SCIENCE ABSTRACTS.

Section A.—PHYSICS.

SEPTEMBER, 1929.

GENERAL PHYSICS.

2645. Pendulum Suspension. F. Tricomi. *N. Cimento,* 6. *pp.* 106–122, *March,* 1929.

An examination of the motion of a compound pendulum suspended by an elastic lamina. Leads to a revision of the known formulæ for the flexion of a bar fixed at one end, eliminating the condition that the bending force should be a shearing force. A. D.

2646. Modified Pirani Vacuum Gauge. T. de Vries. *J.O.S.A. and R.S.I.* 18. *pp.* 333–335, *April,* 1929.

Four carbon or tungsten lamps are assembled in a Wheatstone bridge arrangement, those in the opposite arms of the bridge being connected to the vacuum line. The other two bulbs serve as balancing resistances, together with a dial-decade resistance box in series with one of these bulbs to balance the bridge. The value of this resistance is a measure of the pressure. The gauge can be used at constant current or voltage and forms a simple means of controlling low pressures or detecting small changes. The conditions of maximum sensitivity are obtained. R. S. R.

2647. Sensitive Form of Pirani Gauge for Measuring High Vacua. L. F. Stanley. *Phys. Soc., Proc.* 41. *pp.* 194–203; *Disc.,* 203–204, *April,* 1929.

The low-pressure gauge here described consists of a manometer and a compensator of identical construction placed in the opposite arms of a Callendar-Griffiths bridge. Each comprises, essentially, a loop of 10 cm. of platinum wire, 0·001 in. in diameter, together with a compensating loop of 2 cm. of the same wire. The symmetry of the circuit makes errors due to thermoelectric effects very small. Investigations have been carried out to ascertain how the sensitivity of the instrument depends upon: (1) the diameter of the gauge; (2) the temperature of the wire; (3) the temperature of the external walls; (4) the nature of the material of the external walls. The gauge follows variations of pressure with considerable rapidity, and its range of measurement is from 2×10^{-3} mm. to 4×10^{-6} mm. approximately. AUTHOR.

2648. Integration of Flowmeter Diagrams. J. L. Hodgson. *Journ. Sci. Instruments,* 6. *pp.* 116–118, *April,* 1929.

In the case of recording flowmeters for which the movement of the pen is proportional to the "orifice-head," or to some other differential pressure which is proportional to the square of the flow, it is often a matter of doubt as to whether too much error will be involved by assuming that the mean flow is proportional to the square root of the mean head shown on the diagram; which mean head can easily be obtained by using an ordinary "area-measuring" or "radial" planimeter. Actually the true flow is proportional to the mean of the square roots of the heads, so that the error involved depends upon the ratio of this quantity to the square root of the mean head. In the present article this error is evaluated for various types of diagrams for the first time, and a general rule is derived which enables one to see at a glance whether a diagram can be integrated directly by means of an ordinary planimeter, or whether it must first be replotted on a flow basis or integrated by means of a special square-rooting planimeter. AUTHOR.

2649. Capillary-Tube Method for the Simultaneous Determination of Surface Tension and Density. A. Ferguson and J. A. Hakes. *Phys. Soc., Proc.* 41. *pp.* 214–222; *Disc.,* 222–223, *April,* 1929.

A capillary tube of radius r is immersed vertically to a depth h_1 in the liquid of density ρ_1 under test. The pressure $g\rho h$ required to force the meniscus down to the lower end of the capillary and to hold it there is measured. If h_1, and consequently h, be varied, a plot of ρh against $(h_1 - r/3)$ gives a straight line from whose slope and intercept the surface tension and the density of the liquid may be inferred. AUTHORS.

2650. Internal Friction of Air. M. Lombardini. *Accad. Lincei, Atti,* 9. *pp.* 63–68, *Jan.* 6, 1929.

Calculates the virtual internal friction of air from the observations in Vigna del Valle. It comes out as 22·8 C.G.S. units, which is 100,000 times greater than the viscosity of air as calculated in the laboratory. The constant of superficial friction is 0·00135 as against Taylor's 0·0023. E. E. F. d'A.

2651. Measurement of the Internal Friction of Metals, Particularly of Mercury. F. Sauerwald and W. Radecker. *Zeits. f. Physik,* 54. 11–12. *pp.* 844–847, 1929.

A preliminary communication giving some experimental results; it appears necessary to assume that the values of the internal friction of mercury given by other authors are correct, apart from ordinary experimental errors. There does not appear to be any considerable slip between the metal and any of the materials used to contain it so far investigated; and for the present no such slip need be assumed in the case of other liquid metals. In judging measurements of the inner friction of metals special criteria are necessary, including the question of Hagenbach's correction. H. N. A.

2652. Influence of Size of Specimen on Viscosity Tests in Metals. J. Cournot. *Comptes Rendus,* 188. *pp.* 995–998, *April* 8, 1929.

Tests were made at 15,100 and 200° C. on aluminium (99·9 % pure) and at 200°, 300° and 350° C. on duralumin, in the form of wires 1 mm., 2 mm., 2·5 mm. and 2·8 mm. diameter, all previously heat-treated at 350° C. Measurements of the rate of flow under various loads show that the practical limit of viscosity rises with the diameter of the wire—very rapidly for fine wires, and more slowly as the diameter increases. The effect of increase of temperature in lowering the limit of viscosity is much more marked in fine wires than in the heavier wires. A. J. M.

2653. Superior Limits of Dynamical Displacement in Elastic Systems. G. Krall. *Accad. Lincei, Atti*, 9. *pp*. 157–163, *Jan*. 20, 1929.

A mathematical investigation of the superior limits of the displacement of an elastic body vibrating under the action of forces constant or variable with time, starting from the most general initial circumstances of the motion. J. J. S.

2654. Forces and Deformations in Rubber. R. Ariano. *N. Cimento*, 6. *pp*. 123–156, *March*, 1929.

The relations in rubber do not differ, except numerically, from those in metals. Recent theories as to the structure of crude rubber shown to lead to a model capable of explaining the physico-mechanical properties of this substance; and the influence of several variables upon the relations between forces and deformations in vulcanised rubber examined. A. D.

2655. Free Periods of a Composite Elastic Column or Composite Stretched Wire. C. H. Lees. *Phys. Soc., Proc*. 41. *pp*. 204–213; *Disc*., 213, *April*, 1929.

The free periods of the longitudinal oscillations of an elastic column, one portion of which has different elastic properties from the remainder, are determined for different positions of the junction when both ends of the column are nodes, when one is an anti-node, and when both are antinodes. A graphical method of dealing with the problems is developed. Observations in the case of a composite stretched wire agree with the theoretical results. AUTHOR.

2656. Forced Vibrations of Liquid Membranes with Conical Points and Vortex Phenomena. R. Tréhin. *J. de Physique et le Radium*, 10. *pp*. 115–128, *March*, 1929.

A study of the vibrations of liquid membranes in circular, square, equilateral triangle frames, and also spherical; the vibrations being forced by sound. The phenomena seem rather capricious; nodal lines shift, conical points sometimes appear at the anti-nodes and vortices appear in the plane of the membrane. Other things being equal, one obtains more simple and stable figures for more viscous liquids, smaller membranes and higher frequencies. W. G. B.

2657. Crystal Structure Theory. Parts II, III and IV. C. Hermann. *Zeits. f. Krist*. 69. 3–4. *pp*. 226–270, *Dec*., 1928, *and* 69. 5–6. *pp*. 533–555, *Feb*., 1929.

A systematic vector treatment of space-group theory with new nomenclature. Symbols such as $D_{2h}p\mu\gamma\nu$ for the old V_h^{16}, to give more information of the symmetry of the particular space-group, are proposed.

W. H. GE.

2658. Theory of Liquid Crystals. E. Alexander and K. Hermann. *Zeits. f. Krist*. 69. 3–4. *pp*. 285–299, *Dec*., 1928.

Gives a theoretical treatment of the symmetry properties of liquid crystals in which the three-dimensional regularity of arrangement of the solid crystal gives way to a two-dimensional regularity. A complete list of two-dimensional space groups is given. W. H. GE.

2659. Crystal Structure of Rare Earth Sesquioxides. L. Pauling. *Zeits. f. Krist*. 69. 5–6. *pp*. 415–421, *Feb*., 1929.

A structure is proposed for the A-modification of the crystals La_2O_3,

Ce_2O_3, Pr_2O_3 and Nd_2O_3, which agrees with the powder photographic data published by Zachariasen, as well as does the structure proposed by him. The new structure has the space-group symmetry D_{3d}^3, and is in better agreement with current views on interionic distances and on the structures of other oxides. W. H. Ge.

2660. Crystal Structure of Rare Earth Sesquioxides. W. Zachariasen. *Zeits. f. Krist.* 70. 1–2. *pp.* 187–189, *April,* 1929.

Further experiment and calculation in reply to the criticism of Pauling [see preceding Abstract]. W. H. Ge.

2661. Crystal Structure of Garnets. G. Menzer. *Zeits. f. Krist.* 69. 3–4. *pp.* 300–396, *Dec.,* 1928.

X-ray examination by the photographic methods of six garnets gave the following data:—

Substance.	Lattice Constant in Å., ±0·003.	Density, ±0·02.	Unit Cell.
$Ca_3Al_2Si_3O_{12}$	11·840	3·605	Body-centred cubic containing 8 molecules. Space group O_h^{10}.
$Ca_3Fe_2Si_3O_{12}$	12·026	3·871	
$Ca_3Cr_2Si_3O_{12}$	11·950	3·858	
$Fe_3Al_2Si_3O_{12}$	11·497	4·235	
$Mn_3Al_2Si_3O_{12}$	11·603	4·197	
$Mg_3Al_2Si_3O_{12}$	11·510	3·732	

The work is reported and the proposed structure discussed in detail. W. H. Ge.

2662. Structural Relation of Alkali Sulphates. B. Gossner and F. Mussgnug. *Zeits. f. Krist.* 69. 5–6. *pp.* 446–454, *Feb.,* 1929.

From rotation and powder X-ray photographs the constants of sodium sulphate were found to be $a = 9 \cdot 79$ Å.; $b = 5 \cdot 89$ Å. and $c = 12 \cdot 31$ Å.; density $= 2 \cdot 673$; 8 molecules of SO_4Na_2 in the unit cell; space-group V_h^{24}. The proposed structure is discussed in relation to the other isomorphous sulphates. W. H. Ge.

2663. Crystal-Growing Apparatus. A. Schubnikow. *Zeits. f. Krist.* 69. 5–6. *pp.* 516–518, *Feb.,* 1929.

Description, with diagrams, of a thermostatically controlled tank suitable for growing crystals from solution. W. H. Ge.

2664. Morphology of Hematite. H. Bläsch. *Zeits. f. Krist.* 70. 1–2. *pp.* 1–159, *April,* 1929.

An elaborate monograph on the morphology of hematite crystals determined by the use of the optical goniometer. W. H. Ge.

2665. Space Group of Pentaerythritol Tetraacetate. I. E. Knaggs. *Zeits. f. Krist.* 70. 1–2. *pp.* 185–186, *April,* 1929.

Contains photographs which show that the space group is C_{4h}^4, and ot C_{4h}^3, as suggested by Gerstäker, Möller and Reis. The distinction between the two space groups lies in the presence or absence of odd order reflections from the (001) planes; these are absent with C_{4h}^{4} and present with C_{4h}^{3}. In a rotation photograph taken with copper *K*-radiation with [100] as rotation axis, a weak spot is found which might be due to a first-order reflection of CuK_{α} rays by the (001) plane, or to a reflection of CuK_{β} rays by the (011) plane; a series of photographs which have been taken, one of them with the CuK_{β} rays cut out by means of a nickel filter, the spot in question being absent, show that the first explanation of the spot is not correct, so that it follows that the space group is C_{4h}^{4}. H. N. A.

2666. X-Ray Comparative Study of Some Silicates. B. Gossner and F. Mussgnug. *Zeits. f. Krist.* 70. 1–2. *pp.* 171–184, *April*, 1929.

From X-ray rotation photographs the constants of three silicates were found to be:—

Substance.	*a*Å.	*b*Å.	*c*Å.	*β*.	Density.	Number of Molecules in Unit Cell.	Space Group.
$SiO_3Be \,.\, AlO_2H$	4·63	14·30	4·71	100° 16′	3·10	4	C_{2h}^{2}
$SiO_3Ca \,.\, BO_2H$	9·64	7·62	4·82	90° 9′	—	4	C_{2h}^{5}
$SiO_3ZnO_2H_2$ . .	8·41	5·14	10·73	90°	3·472	4	C_{2v}^{20}

The relationship of the proposed structures is discussed in detail and compared with that of quartz. W. H. Ge.

2667. Crystalline Structure of Compounds of High Molecular Weight. H. Staudinger and R. Signer. *Zeits. f. Krist.* 70. 3. *pp.* 193–210, *April*, 1929.

The light thrown by X-ray examination on the crystal structures of complex polyoxymethylene derivatives, complicated hydrocarbons of the rubber type, etc., is discussed. T. H. P.

2668. X-Ray Examination of Tourmalines. F. Machatschki. *Zeits. f. Krist.* 70. 3. *pp.* 211–233, *April*, 1929.

X-ray examination by the rotation photographic method and by the ionisation spectrometer of three tourmalines gave the following data: **a = 16·02; 15·81; 15·87 Å. c = 7·22; 7·10; 7·13 Å.** The hexagonal unit cells contain 3 molecules of the type $XY_9B_3Si_6H_xO_{31}$. The composition and the structure of tourmalines are discussed in detail. W. H. Ge.

2669. X-Ray Examination of Enstatite and Bronzite. B. Gossner and F. Mussgnug. *Zeits. f. Krist.* 70. 3. *pp.* 234–248, *April*, 1929.

Reports a partial examination of the mineral enstatite and discusses its relation to the pyroxene and amphibole groups of silicates. W. H. Ge.

2670. X-Ray Study of Mixed Crystals of $BaSO_4$ and $KMnO_4$. G. Wagner. *Zeits. f. phys. Chem.* 2. *Abt. B.* *pp.* 27–38, *Jan.*, 1929.

Mixed crystals of the system $BaSO_4 + KMnO_4$ were studied by means of X-ray powder photographs and were found to be genuine. A powder photograph of $BaSO_4$ to which 15·7 % molecular of $Ba(NO_3)_2$ had been added showed no displacement of the $BaSO_4$-lines. W. H. Ge.

2671. Imperfections of Crystals. F. Zwicky. *Nat. Acad. Sci., Proc.* **15.** *pp.* **253–259,** *March,* **1929.**

On the basis of a previous paper it is shown that in rock-salt, for example, there is a contraction in the surface lattice plane. The surface cannot contract as a whole, but does so in patches of a certain average size, leaving cracks on the surface, which is divided into a mosaic pattern; the distance between cracks is approximately 100 Å. for rock-salt: and from surface energy considerations it is concluded that the depth of the wedge-shaped cracks is about 50 Å. and the width at the top about 8 Å. The technical breaking strength will be determined by the size and shape of the largest cracks, and will thus have a well-defined value. Suggests that a surface grown under suitable conditions might show sufficient regularity in the surface blocks to enable it to be used as a grating for soft X-rays. Discusses chemical imperfections of crystals in relation to cracks, particularly for the case of absorbed gas, and finds that the amount of oxygen absorbed by silver agrees fairly well with the theory that it is distributed over the surface of the mosaic blocks. H. N. A.

2672. Structure of Complex Ionic Crystals. L. Pauling. *Am. Chem. Soc., J.* **51.** *pp.* **1010–1026,** *April,* **1929.**

A set of principles governing the structure of complex ionic crystals, based upon the assumption of a coordinated arrangement of anions about each cation at the corners of an approximately regular polyhedron, is formulated with the aid of considerations based upon the crystal energy. Included in the set is a new electrostatic principle which is of wide application and considerable power. It is shown that the known structures of many complex crystals, in particular the complex silicates, satisfy the requirements of these principles. As an illustration of the application of the principles in the prediction of structures with the coordination theory, some properties of the structures of the three forms of Al_2SiO_5, cyanite, andalusite and sillimanite, are predicted. It is further shown that the theory requires that no stable basic silicates of divalent metals exist, and that in aluminium silicates of alkali metals there should be at least one aluminium ion for every alkali ion. The structures of aluminium silicates of divalent metals which are simplest from the coordination standpoint are shown to correspond to the formulas $R_3^{++}Al_2Si_3O_{12}$ and $R_3^{++}Al_2Si_6O_{18}$, which include the most important minerals of this class, the garnets and beryl. H. H. Ho.

2673. Crystal Structure of Some Compounds of Metals of the Platinum Group. L. Thomassen. *Zeits. f. phys. Chem.* **2.** *Abt. B. pp.* **349–379,** *April,* **1929.**

The powder method has been used to examine the following substances: With pyrites structure: $OsTe_2$, $OsSe_2$, $RuTe_2$, $RuSe_2$, $PtSb_2$. With cadmium iodide structure: $PdTe_2$, $PtTe_2$, $PtSe_2$, PtS_2. With nickel arsenide structure: PdTe. The method of preparation of the substances has been described previously [see Abstract **327** (1929)]. The magnetic properties of the substances have been examined at low temperatures (liquid hydrogen). None of them were found to be ferro-magnetic.

A. A. D.

2674. Crystal Structure of Strontium. A. J. King. *Nat. Acad. Sci., Proc.* **15.** *pp.* **337–338,** *April,* **1929.**

Reference is made to the work of Simon and Vohsen (see Abstract **2064**

(1928)]. Powder diffraction data for strontium foil are obtained which confirm the results of Simon and Vohsen that the structure of strontium is face-centered cubic or some form closely resembling this type of lattice.
J. K.

2675. Recrystallisation in Aluminium Crystals. Part II. Orientation of the Crystals formed after Strong Deformation.

W. G. Burgers and J. C. M. Basart. *Zeits. f. Physik*, 54. 1–2. *pp.* 74–91, 1929.

Having studied the crystal orientation in single crystals of Al after elongation by stretching to 10–15 % [see Abstract 689 (1929)], the authors roll single crystals of a few cm. length and width, 0·5 mm. thick, down to ¼ thickness in different directions, determine the orientation by means of Laue and Debye-Scherrer X-ray examinations in the original and the worked conditions, and take samples for heating up to 600° for a few seconds and for hours (up to 24). The rolling down to ¼ thickness is, according to van Arkel and van Bruggen [see Abstract 400 (1929)], best for the development of surface crystals. The structure after rolling is in general reproducible and is connected with the direction of rolling and the lattice structure. The crystallisation consequent upon short heating indicates mostly (but not always) a preferential orientation. In most of the crystallites the orientation is not the same after recrystallisation as after rolling; but this does not hold for less strong rolling. Recrystallisation after long annealing is probably another process, though there is also a preferential orientation; some crystallites grow to larger grains, but coalescence of several crystallites of the same orientation seems to be more frequent. Parts of the same mother crystal, rolled in different directions, may behave differently. Glocker's view that the structure of rolled, originally polycrystalline, sheet metal is always fibrous, with the direction of rolling as fibre axis, is not supported. Further study of the fine mechanism and of twinning is required. Some striking radiograms are reproduced.
H. B.

2676. Structure of the Benzene Ring in Hexamethylbenzene.

Kathleen Lonsdale. *Roy. Soc., Proc.* 123. *pp.* 494–515, *April* 6, 1929.

As benzene is not crystalline at ordinary temperature, the structure of its ring has to be referred to its derivatives, and those researches left it doubtful whether the ring was puckered (as in diamond) or plane (as in graphite). Hexamethylbenzene has the advantage that the unit cell, found to be triclinic, contains only one molecule. The crystal of this $C_6(CH_3)_6$ melts at 164°, the lengths of the axes of the flat prisms are $a = 9{\cdot}010$, $b = 8{\cdot}926$, $c = 5{\cdot}344$ Å., and the angles $\alpha = 44° 27'$, $\beta = 116° 43'$, $\gamma = 119° 34'$. The unit cell is probably centro-symmetrical and the structure hexagonal in the zone [001]. All carbon atoms lie within 0·1 Å. of this cleavage plane, but successive (001) planes are displaced with respect to one another, which was not expected. The cleavage is very good, though not quite so remarkable as in graphite. The benzene ring resembles the graphite ring in shape and size, the aromatic carbon atoms having a diameter of 1·42 Å.; three of the valencies of aromatic carbon are coplanar. The structure of a puckered ring and the more compact model of J. K. Morse [see Abstract 813 (1928)] are inadmissible. The methyl group does not scatter like a single atom, but is heavily weighted in scattering power at the end nearer the benzene ring. H. B.

2677. Determination of the Parachors of Substances in Solutions. D. L. Hammick and L. W. Andrew. *Chem. Soc., J. pp.* 754–759, *April*, 1929.

Experiments are made to ascertain whether the parachors of substances unstable in the pure liquid state can be calculated from the surface tensions and densities of their solutions of known parachors. The parachor P_m of a solution containing a molecular fraction x of solute in a solvent of known parachor P is first determined; this P is equal to $M_m\gamma^{\frac{1}{4}}(D - d)$, where γ and D are the surface tension and density of the solution, d is the density of the vapour (negligible at 25°) and M is the mean molecular weight of the mixture. If the parachors obey the straight-line mixture law, $P_m = P(1 - x) + P_x . x$. This is practically confirmed for four classes of solutions: (1) neither the solute nor the solvent is associated (*e.g.*, carbon tetrachloride in benzene); (2) only the solute is associated (ethylalcohol in benzene); (3) only the solvent is associated (ethylacetate in acetic acid); (4) both solvent and solute are associated (acetic acid in alcohol). For all these substances the straight-line law is found to hold, and the parachor of the solute is independent of the solution. In the cases of nitrobenzene or ethyl ether in benzene and of nitrobenzene in carbon tetrachloride the solute parachor falls off linearly with the dilution. Practically, however, it may be said that the mixture law applied to a series of solutions will give either the parachor of the pure solute or a series of values from which the value for the pure solute can be obtained by extrapolation. H. B.

2678. Molecular Dimensions of Organic Compounds. Part I. T. M. Lowry and A. G. Nasini. *Roy. Soc., Proc.* 123. *pp.* 686–691, *April* 6, 1929.

The resemblance which V. Meyer observed in the boiling-points of benzene and thiophen and of their derivatives has been made the basis of a comparative study of the physical properties of benzene with thiophen and of toluene with alpha-methylthiophen. A comparison has also been made of the physical properties of benzene and cyclohexane, since the boiling-points and freezing-points of these two hydrocarbons are almost identical. Measurements have been made of the viscosities of the vapours of benzene, toluene, cyclohexane, thiophen, methylthiophen and pyridine. From these results the mean collision areas and the values of Sutherland's constant have been deduced. In spite of the close resemblance of benzene to thiophen and of toluene to methylthiophen, the collision-areas are altered by about 10 % when two CH-groups are replaced by an atom of sulphur; in each case, however, the change is accompanied by an almost constant decrement of 2 Å.^{2}. On the other hand, the replacement of H by CH_3 is accompanied by a constant increment of 3 Å.^{2}. The collision-area of the molecule is also increased by about 1 Å.^{2} when one CH-group is replaced by an atom of nitrogen on passing from benzene to pyridine. As a result of these increments and decrements, the collision-area of methylthiophen, which differs substantially from that of toluene, is practically identical with that of pyridine. A marked similarity, not recorded hitherto, is also observed between other physical properties (*e.g.*, the boiling-point and the freezing-point of these two liquid compounds). In none of the cases now investigated is the similarity of properties as close as in Langmuir's isosteric compounds. Thus the vapours exhibit regular increments rather than identity of properties; and the physical properties of the liquids and solids, which depend on the force-fields of the molecules as well as on their dimensions, show still wider differences. A. D.

2679. Molecular Dimensions of Organic Compounds. Parts II. and III. A. G. Nasini. *Roy. Soc., Proc.* 123. *pp.* 692–713, *April* 6, 1929.

Apparatus based on Rankine's methods is used for determining the viscosity of benzene from 15° to 251°, that of toluene from 61° to 252°, and that of cyclohexane from 46° to 205°. Sutherland's constant for these three hydrocarbons respectively is 380, 370 and 330; the collision-areas are 19·0, 21·8 and 22·3. With apparatus modified by using a zero pressure on the condensation side of the capillary, the viscosities of thiophen, methylthiophen and pyridine have been measured; the Sutherland constants of these three are 407, 400 and 320; the collision-areas are 16·7, 19·9 and 20·0. A. D.

2680. Spectral Relations between Certain Iso-Electronic Systems and Sequences. Part I. CaI, ScII, TiIII, V IV, and Cr V. H. E. White. *Phys. Rev.* 33. *pp.* 538–546, *April*, 1929.

Use is made of a Moseley diagram in which the square roots of corresponding energy levels are plotted against the atomic numbers for an iso-electronic sequence, *i.e.*, a sequence of ions each containing the same total number of electrons. Extrapolations from the known data for CaI, ScII and TiIII lead to the spectroscopic identification of some thirty energy levels in both triply ionised vanadium and quadruply ionised chromium, which belong to the same iso-electronic sequence. The "ionisation potentials" of V IV and CrV are determined at about 48·3 volts and 72·8 volts respectively. W. S. S.

2681. Regularities in the Table of Elements and their Cosmological Import. D. Strömholm. *Phil. Mag.* 7. *pp.* 691–705, *April*, 1929.

Assumes that the nuclei are mainly built up of positive units of weight 2, formed of 2 protons joined by 1 electron, with a certain number of additional electrons in the majority of elements. Many elements of low atomic number have none of these additional electrons. The ratio between the number of the above positive units and that of the additional electrons decreases on the whole from atomic number 21 upward, so that the percentage of electrons increases. This change proceeds by leaps, and the elements are divided into groups 1 to 20, 21 to 30, 31 to 47, 48 or 49 to 60, 62 to 72, 73 to 83. Considers it possible that the elements were formed under the influence of the high temperatures and pressures existing in the interior of the earth, the different groups being formed in different layers, the light elements higher up and the heavier ones lower down. Thinks that the known densities of the planets are consistent with this view.

H. N. A.

2682. Transition Probabilities in the Lithium Atom. B. Trumpy. *Zeits. f. Physik*, 54. 5–6. *pp.* 372–384, 1929.

Using the eigen functions of the lithium atom found in a previous paper [see Abstract 3172 (1928)], the total relative intensity of the continuous spectrum at the head of the principal series of lithium is worked out. The value obtained equals 0·24 against 0·256 found by Hargreaves using Hartree's method of the self-consistent field [see Abstract 1456

(1929)]. Despite the good general agreement in these figures, the present calculations do not imply a maximum in the $\frac{df}{de}$ curve as obtained by Hargreaves. Definite experimental evidence on this point is lacking, but as far as the measurements show, it is unlikely that this maximum actually exists. W. S. S.

2683. Heat of Dissociation of Nitrogen. J. Kaplan. *Nat. Acad. Sci., Proc.* 15. *pp.* 226–229, *March,* 1929.

Gaviola has recently presented evidence for a value of the heat of dissociation of the nitrogen molecule considerably smaller than the hitherto accepted value of about 11·4 volts, while Birge and Mulliken [see Abstract 1053 (1929)] have independently obtained a value of about 9·5 volts. The work of Birge, Mulliken, Miss Sponer and others is discussed, and the conclusion is reached that the heat of dissociation of the nitrogen molecule is about 9·0 volts. A. W.

2684. Two-Quantum Excited States of the Hydrogen Molecule. E. C. Kemble and C. Zener. *Phys. Rev.* 33. *pp.* 512–537, *April,* 1929.

The theory of two-quantum states of H_2 (*i.e.*, molecular states which dissociate into a normal atom and a two-quantum atom on adiabatic separation of the nuclei) is developed. There are sixteen possible wave functions giving rise to eight distinct S states and four distinct P states (degenerate in fixed nuclei problem); and these fall into four groups of three according to the symmetry of the wave functions. Selection principles for transitions between these various types of electronic state are deduced. First order perturbation theory is used to compute the potential energy curves for the P states; it appears that two of them have the right form for stable molecules, and these are identified with the upper level for the Werner bands and with the 2^3P state reported by Richardson. The analysis indicates that, contrary to London's original valency theory, the union of valence electrons to form symmetrical pairs is not, in the case of the excited states of hydrogen, the essential feature of molecule formation, which is probably more generally contingent on the removal of degeneracy from the wave functions of the interacting atoms. W. S. S.

2685. Commutation Rules in Algebra of Quantum Mechanics. N. H. McCoy. *Nat. Acad. Sci., Proc.* 15. *pp.* 200–202, *March,* 1929.

The algebra of the new quantum mechanics is a special form of the algebra of matrices. For one pair of canonically conjugate variables its properties are determined by the assumption $pq - qp = C$, where q and p are matrices which represent the co-ordinate and momentum respectively. The value of the constant C plays no part in the development of the algebra, although in the quantum mechanics it is assigned the value $h/2\pi i$. The theory of the differentiation of the functions of a matrix is discussed together with some interesting formal results, the paper concluding with the brief mention of functions of more than one pair of canonically conjugate variables. H. H. Ho.

2686. Hypercomplex Numbers Used in the Wave Equation. J. A. Schouten. *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 105–108, 1929.

Eddington's recent papers [see Abstract 1064 (1929)] describe a considerable improvement in the method of treatment, but the foundation of the new method is not quite satisfactory, since it depends on the introduction of certain remarkable and rather improbable rotations, which only serve to provide the operators $E_1 \ldots E_5$ with the required properties. It is shown that these rotations can be dispensed with by starting with the theory of the systems of complex numbers; it appears that the smallest system of numbers that can come into question is the " original " system with 16 units, and the properties of the operators E, including the possibility of representation by matrices, can be deduced from the known properties of these systems. H. N. A.

2687. Linear Transformations in Hilbert Space. Parts I and II. M. H. Stone. *Nat. Acad. Sci., Proc.* 15. *pp.* 198–200, *March, and pp.* 423–425, *May,* 1929.

Part I summarises and extends from the geometrical standpoint some recent developments of Hilbert's classical theory of transformations in space of infinitely many dimensions. By a suitable combination of Carleman's fundamental methods and the ideas of von Neumann, transformations in complex space are dealt with, this being made possible by the introduction and utilisation, *ab initio,* of the inverses of certain transformations. Part II develops analytical representations of such transformations or operators for which purpose the concept of a canonical resolution of the identity is first defined. H. H. Ho.

2688. Possible Line Elements for the Universe. R. C. Tolman. *Nat. Acad. Sci., Proc.* 15. *pp.* 297–304, *April* 15, 1929.

Line elements, proposed respectively by Einstein and de Sitter, together with that given by the special theory of relativity, are shown to be the only ones compatible with " natural " assumptions relating to the universe. These assumptions ignore the possible occurrence of a universal evolutionary process. J. S. G. T.

2689. Gravitation and the Electron. H. Weyl. *Nat. Acad. Sci., Proc.* 15. *pp.* 323–333, *April* 15, 1929.

The author attempts to incorporate Dirac's electron theory in the scheme of general relativity. The metric is established by a " Cartesian " system of axes consisting of four vectors, of which three are real space line vectors whilst the fourth is directed towards the future. Tensor calculus cannot be employed. In its formal aspects the theory resembles Einstein's recent unified field theory; there is, however, no reference to " distant parallelism." A unification of gravitation and electricity without taking material waves into account is considered to be hopeless. The electromagnetic field is a necessary accompaniment of the matter-wave field, and not of gravitation. J. S. G. T.

2690. Spherically Symmetrical Statical Field in Einstein's Unified Theory of Electricity and Gravitation. N. Wiener and M. S. Vallarta. *Nat. Acad. Sci., Proc.* 15. *pp.* 353–356, *April,* 1929.

The nature of the potential tensor, $\Lambda^{\sigma}_{\mu\sigma}$, of Einstein's unified theory is investigated under the assumptions made to obtain Schwarzschild's solution of the spherically symmetrical statical field of the 1916 theory. An electromagnetic field is shown to be incompatible in the new theory, with such symmetry and symmetry of past and future. J. S. G. T.

METEOROLOGY AND GEOPHYSICS.

2691. Simple Method of Measuring the Diffused Radiation of the Sky according to Zones. N. N. Kalitin, with Discussion by H. H. Kimball. *Monthly Weather Rev*, 57. *pp.* 52–53; *Disc.*, 53–54, *Feb.*, 1929.

The author arranged an Ångström pyranometer on the axis of an outer cylinder with vertical movement which permits exposure to the whole vault, or the elimination of successive 10° zones from the horizon up to 80°. It is shielded from direct solar radiation, and the observations are obtained with a Zeiss schleifen-galvanometer. The series of measurements takes 3 to 4 minutes. A table and graphs are given for four examples. A maximum for clear skies is found in the 30°–40° zone and for overcast skies in the 60°–70° zone. For the former radiation is greater at the horizon than at the zenith, but for the latter the reverse holds. The apparatus permits observations being made on the effect of different meteorological conditions and topography on diffuse radiation. R. S. R.

2692. Deep-Seated Gravitational Masses. A. Belluigi. *Accad. Lincei, Atti*, 9. *pp.* 60–63, *Jan.* 6, 1929.

Describes a new mathematical method of obtaining the influence of a subterranean mass of indefinite extent by dividing it into a series of orthogonal vertical sections, and obtains a simple formula which may be useful in certain cases. E. E. F. d'A.

2693. Continental Origins. W. Bowie. *Gerlands Beitr. z. Geophys.* 21. 2–3. *pp.* 178–182, 1929. *In English.*

Assuming the isotatic equilibrium to be proved, the question arises as to how the lighter granitic material is concentrated in Continental areas. On the planitesimal theory, or any theory of a molten origin, it must have originally been uniformly spread over the earth's surface. The Fisher-Darwin theory that the moon originated by tidal disruption of the surface or by explosion alone covers the facts. The site would be the present Pacific. The low density of the moon, the structure and arrangement of the continents all favour the theory. The expulsion probably took place just after coastal solidification and before life appeared on the earth. W. A. R.

ASTROPHYSICS.

2694. Proper Motion of Long-Lived Sunspots. K. Sotome. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 116–118, *March*, 1929. *In English.*

The author finds that solar atmospheric refraction influences the positions of sunspots with respect to their distance from the centre of the disc, and deduces the angular velocity free from that effect in the form $\xi = 14^\circ{\cdot}44 - 2^\circ{\cdot}31 \sin^2 \phi$. He applies this to the proper motions of long-lived spots, giving tables and diagrams of the longitudes of leader spots and diagrams of their areas. He finds that the appearance and disappearance of a spot occurs nearly in the same longitude, the forward movement being quick and the return slow. The maximum area corresponds to the utmost displacement. A. S. D. M.

2695. Sun's Radial Magnetic Gradient and Atmosphere. R. Gunn. *Phys. Rev.* 33. *pp.* 614–620, *April*, 1929.

The author first deals with the theory of the radial magnetic gradient of the sun based on the diamagnetic effect produced by ions spiralling about

the impressed magnetic field. The thermal ionisation of the sun's atmosphere, free paths and velocities of thermal agitation of the molecules and ions all have such values that the diamagnetic effect is very large in the regions of the sun's atmosphere where abnormally large magnetic gradients are observed. Extrapolation of the diamagnetic effect into regions where there are no available experimental data shows that the magnetic field at the surface of the sun is several times the generally accepted value. Ionic densities are estimated from magnetic data and agree well with data from other sources. The mean atomic weight of the particles in the sun's atmosphere, assuming it to be in purely gravitational equilibrium, is found to be approximately 3·3, which becomes 5·5 when a correction is made for the presence of an electric charge on the sun.
H. H. Ho.

2696. Spectroscopic Determination of Pressure in the Calcium Chromosphere. A. Unsöld. *Mt. Wilson Observat., Contrib. No.* 377. *Astrophys. J.* 69. *pp.* 209–226, *April*, 1929.

In a previous paper [see Abstract 1200 (1928)] it was shown that the structure of emission lines showing self-reversals in the spectrum of the sun's limb depends on the pressure of the chromosphere, and not on the total optical depth of the solar atmosphere for the corresponding wavelength. This theory is now extended for the case of the Ca^+ resonance lines H and K. It is proved that the spectral distribution of the coefficient of scattering of the upper layers of the chromosphere is essentially the result of Doppler effect of the Ca^+ atoms. The pressure and even the variation of pressure with height in the chromosphere may then be deduced from the observations, and we obtain pressures of about 10^{-15} atmospheres. The radiation which is removed by the chromospheric absorption lines H_3 and K_3 exactly suffices to support the mass of Ca^+ corresponding to the above pressure, and thus the fundamental requirement of Milne's theory is fulfilled. Some further considerations of the dynamics and the stability of the chromosphere are added. M. A. E.

2697. Law of Attraction. Neronoff. *Comptes Rendus,* 188. *pp.* 1148–1151, *April* 29, 1929.

Calculates the attractive force between a planet and the sun on the assumption of a given form for the law of attraction, and a simple relation between the density of the sun's mass and the distance from its centre. To a first approximation the law of attraction is

$$U = fmM\left\{\frac{1}{\rho} + \frac{3fM}{c^2\rho^2} + \ldots\right\},$$

where U is the potential, f a constant, M the sun's mass, and ρ the distance of the planet. J. W. T. W.

2698. Determination of Geographical Latitude at the Astronomical Observatory of the Warsaw University. F. Kępiński. *Acad. Polonaise Sci. et Lettres, Bull.* 1a. *pp.* 23–37, *Jan.*, 1929. *In French.*

The author tabulates the results obtained for a series of measurements of stars, a zenithal telescope of Wanschaff being employed, furnished with two Horrebow levels. A systematic difference was obtained for stars to the east from those to the west, and noticed in all parts of the year and of the night. R. S. R.

2699. Heliocentric Velocity of Meteors. C. Hoffmeister. *Astrophys. J.* 69. *pp.* 159–167, *March,* 1929.

Observations of shooting stars show that for the majority the mean heliocentric velocity is far too great to imply a cometary origin, being 2·4 times the earth's orbital speed and a whole unit greater than the parabolic. Apart from a certain number of cometary swarms, meteors move in strongly hyperbolic orbits and must come to us from interstellar space. Fessenkoff and Olivier agree with this view, and Oepik's criticisms are here refuted. The author refers to papers he has published in earlier years and promises a more extensive work shortly. M. A. E.

2700. Line Intensities in Nebular Spectra. H. H. Plaskett. *Harvard Coll. Obs., Circ. No.* 335. [24 *pp.*], *Nov.* 28, 1929.

The spectrophotometric determination of line intensities in nebular spectra is a problem which gives promise of yielding valuable clues to the physical nature of nebulæ. An account is given in the present paper of a preliminary investigation of this field, methods and results appearing in the first two sections and a discussion in the third. Apart from the line intensities themselves, the principal results reached in the paper are first the conclusion that the Balmer spectrum is produced on recombination; secondly, the deduction from the observed line intensities of the fraction of hydrogen atoms which capture an electron on a given state; and thirdly, the observational confirmation of Bowen's suggestion that the forbidden lines of O^{++} are emitted after excitation by an inelastic impact with a free electron. AUTHOR.

2701. Large Radial Velocity of N.G.C. 7619. M. L. Humason. *Nat. Acad. Sci., Proc.* 15. *pp.* 167–168, *March,* 1929.

Hubble, having found a marked increase of radial velocity with distance in 24 extra-galactic nebulæ, suggested that fainter and more distant nebulæ should be observed, in order to determine whether large displacements to red appear in the spectra, as might be expected on de Sitter's theory of curved space-time. The spectrum of the small globular nebula N.G.C. 7619 has been photographed with the 100-inch telescope, and its radial velocity computed at 3779 km./sec., which is twice as large as any hitherto observed. This high velocity falls on Hubble's extrapolated line which expresses the relationship between line-displacement and distance. The spectrum is F8, and the wide diffuse lines resemble those of other extra-galactic nebulæ: this character is probably due to dispersion in velocity and blending of the spectral types of many stars which doubtless exist in the depths of these nebulæ. It is hoped soon to determine velocities of other similar nebulæ. M. A. E.

2702. Longitude of Galactic Centre as Derived from the Intensities of Detached Calcium Lines. O. Struve. *Nat. Acad. Sci., Proc.* 15. *pp.* 163–166, *March,* 1929.

Considerable evidence points to the centre of our galactic system being identical with that of the system of globular clusters, which was placed by Shapley approximately in galactic longitude 325°. Oort's centre of galactic rotation lies in the same direction, and his work has been amply confirmed by others. The determinations of Ca^{+} intensities in early-type stars, made by the writer at Harvard, are fairly uniform with respect to limiting magnitude, and it might therefore be expected that the mean intensity of these interstellar lines would vary with galactic longitude. It is here shown that this relation does exist, and that the strongest lines are found in stars near galactic longitude 325°. M. A. E.

2703. Studies of the Galactic Centre. Part IV. Transparency of the Galactic Star Clouds. H. Shapley. *Nat. Acad. Sci., Proc.* 15. *pp.* 174–177 *March,* 1929.

The star clouds in Sagittarius appear to constitute a nucleus of our Galaxy, but dark nebulosities in the neighbourhood might make hopeless the attempt to measure its bounds beyond the centre. The transparency of the Galaxy in any direction, however, can be tested with the aid of the extra-galactic nebulæ, and a systematic examination of plates for new nebulæ in this region has been carried out. It is found that many are visible within 20° of the centre and 10° of the central line of the Galaxy, and that effective obscuration is apparently limited to easily recognised dark nebulosities. It seems, therefore, that though the centre itself and some of the star-clouds in the central region are hidden, the Galaxy is completely transparent at the borders of the dark nebulosities, so that we can observe not only the most distant stars of our system, but also the outside galaxies, probably millions of light-years beyond. Three figures show the galactic centre, with the star-clouds, the obscuring nebulosities, and the extra-galactic nebulæ beyond. M. A. E.

2704. Distance and Radial Velocity among Extra-Galactic Nebulæ. E. Hubble. *Nat. Acad. Sci., Proc.* 15. *pp.* 168–173, *March,* 1929.

Determinations of the motion of the sun with respect to the extra-galactic nebulæ have involved a K term of several hundred kilometres which appears to be variable. Explanations of this paradox have been sought in a correlation between apparent radial velocities and distances, and the present paper is a re-examination of the question, based on only those nebular distances which are believed to be fairly reliable. Distances can be derived from absolute luminosity criteria when stars are involved whose types can be recognised; and another, though less certain, test can be applied when even a few stars can be detected, for it appears that there is an upper limit of absolute-magnitude $-6\cdot3$ to their brightness. In addition, the extra-galactic nebulæ themselves appear to have an average luminosity of $-15\cdot2$, with a range of only four or five magnitudes about this value: therefore, especially where many nebulæ are clustered together, the mean apparent luminosities offer reliable estimates of the mean distances. Twenty-four nebulæ are here tabulated whose distances have been found in one of these ways, and whose radial velocities are known, and the results indicate a linear correlation between distance and velocity. A consideration of 22 more nebulæ, whose radial velocities are known, but not their individual distances, supports the conclusion. This will be modified or confirmed by further research now in progress, especially Humason's investigations of the most distant nebulæ that can be observed at Mt. Wilson. If the velocity-distance relation here found represents the de Sitter effect, it will become possible to introduce numerical data into discussions of the general curvature of space. M. A. E.

2705. Spiral Nebula as a Stellar System. Messier 31. E. Hubble. *Mt. Wilson Observat. Contrib. No.* 376. *Astrophys. J.* 69. *pp.* 103–158, *March,* 1929.

From an extended study of about 350 photographs taken with 60-inch and 100-inch reflectors, and representing about 40 % of the entire nebula, it is found that the outer regions are partially resolved into swarms of faint stars, whilst the nuclear region shows no indications of resolution at all. Fifty variables have been found, nearly all in the outer regions of which forty are known to be cepheids with periods from 48 days to 10 days. Of the 10 remaining variables 4 are probably faint cepheids and 6 are irregular or long period variables. Sixty-three further novæ have been found by the author, now giving a total of 85 observed photographically. Novæ are most frequent in the nuclear region, and it is estimated that novæ appear at the rate of about 30 a year. The mass density of M 31 appears to be of the order of one sun per 20 cubic parsecs, and the luminosity density about 9·0 magnitudes per cubic parsec. The mass = 5·5 L in terms of the sun's mass and luminosity, and these values are of the same order as those for the galactic system in the neighbourhood of the sun. The coefficient of the mass luminosity relation decreases as the nucleus is approached, becoming 0·001 for the nucleus itself. An approximate comparison of sizes, masses, luminosities and densities suggests that the galactic system is much larger than M 31. R. C. F.

2706. Rotation of Local Cluster. H. Mineur. *Comptes Rendus,* 188. *pp.* 1086–1088, *April* 22, 1929.

An investigation of the third-degree ($\phi 3$) terms in the development of the mean radial velocity, V. [see Abstract 1818 (1929)] in a series of spherical functions. The numerical determination of these terms is got from 2100 radial velocities of naked-eye stars in the Lick Observatory Catalogue, and incidentally leads up to a position of the solar apex (A = 274° 19′, D = + 29° 32′, sun's velocity = 19·49 km./sec.). If Ox' is the perpendicular from the sun to the rotation axis, and Oz' parallel to the axis, the author gets, as referred to these axes:—

$$\phi_3 = c_3(4\beta'\gamma'^2 - \alpha'^2\beta' - \beta'^3) + 2c_5\alpha'\beta'\gamma' + c_\gamma(3\alpha'^2\beta' - \beta'^3),$$

the other terms being nil. Taking Ox' as the direction of the local cluster centre, and Oz' the direction of its pole, he gets in galactic coordinates, G = 244° $g = -4°$ and G = 165°, $g = 77°$ respectively, confirming to some extent the results of his former paper. He compares his results with those of Oort and Plaskett, dividing their material into two groups: the 24 values of G° derived from naked-eye stars within 600 parsecs of the sun, and the 9 values from stars beyond this distance, and therefore beyond the local cluster. These two values of G° are distinct, and give the centre of the local cluster as 334° and of the galaxy as 323°. The author concludes that stars near the sun rotate round the centre of the local cluster, those remote from the sun round the centre of the Galaxy, but also that the local cluster must itself participate in this rotation round the galactic centre. The sun's movement in the Galaxy is therefore analogous to that of the moon in the solar system. A. S. D. M.

2707. Building Up of the Elements in Stars. R. d'E. Atkinson and F. G. Houtermans. *Zeits. f. Physik,* 54. 9–10. *pp.* 656–665, 1929.

Calculates from the quantum theory, utilising the method as developed by Gamow [see Abstract 1232 (1929)], the probability of a proton entering the nucleus of an atom. For light elements, at the temperature and density ratios in the interior of the stars, this shows that the penetration of protons, but not of α-particles, does occur sufficiently frequently to allow of the building up of these elements. The possibility of explaining the energy development of the stars is also given by this method which eliminates the necessity for assuming 6 type collisions. Several theoretical considerations regarding the building up of the heavier elements are also given.

R. C. F.

2708. Structure of the Spherical Star Groups. O. Heckmann and H. Siedentopf. *Zeits. f. Physik,* 54. 7–8. *pp.* 518–533, 1929.

Examines the five spherical star groups M10, 12, 15, 53 and 56, assuming that Kienle's observations that the structure is due to accidental fluctuations is correct. The construction of the curves of constant density and the counting of the stars in the groups are critically discussed, whilst the fluctuations of the star numbers are estimated from experimentally obtained curves of constant density. A comparison of these fluctuations with those obtained from theoretical considerations shows that the experimental figures are only 85 % of the theoretical values, the explanation of this difference being probably due to the method of making the counts. No structures analogous to those of the spiral nebulæ are found for the spherical groups. R. C. F.

2709. Stability of Gaseous Stellar Structures. B. P. Gerasimovič. *Nat. Acad. Sci., Proc.* 15. *pp.* 347–353, *April,* 1929.

The stability of gaseous stellar structures is investigated along the lines followed by Jeans, but introducing into the equations additional terms depending on the energy of ionisation. It is shown that the change in ionisation during the perturbed motion of a gaseous star contributes favourably to the stability. The contribution is not large, but is sufficient to ensure the stability of typical giants and supergiants, whilst gaseous dwarfs are stable even without taking account of the variations of molecular weight and ionisation. Certain very infrequent stars of exceedingly large mass, comprising chiefly stars of class O and early B stars, may be at least partly in a " liquid " state. J. S. G. T.

2710. Stark Effect in Stellar Spectra. O. Struve. *Astrophys. J.* 69. *pp.* 173–195, *April,* 1929.

The great widths of the hydrogen lines in stellar spectra are probably due in part to mol-electric Stark broadening. An estimate of the average intensity of intramolecular fields is $10^3 - 10^4$ volts per cm. Measurements of line widths in B- and A-type stars show that narrow and wide lines occur in all spectral subdivisions. The general appearance of the lines agrees with the requirements of theory that H lines should be broadest and the widening lessen with increase in atomic weight. Fields of the order of 10^4 volts per cm. should stimulate lines forbidden by the selection principle, and it is suggested that λ4470 is one such due to He. Balmer lines should broaden in varying proportions, although theory gives larger values than have been found. The evidence is favourable to the idea that broadening in early type stars is partly due to interaction of atoms and free electrons in the reversing layers of the stars. F. S.

2711. Stark Effect in Stellar Spectra. C. T. Elvey. *Astrophys. J.* 69. *pp.* 237–239, *April,* 1929.

The contours of the He lines λ4387 and λ4472 have been determined in the stars 17ζ Cassiopeiæ, 88γ Pegasi, and 85γ Herculis. The line λ4470 appears in the contours of λ4472, the ratio of intensities in the three stars being 0·31, 0·32, and 0·23. This confirms Struve's prediction as to the origin of λ4470 [see preceding Abstract]. The contour of λ4387 is unsymmetrical, indicating a component at λ4386·8 I-Å. of relative intensity 0·21. F. S.

2712. V Ursæ Minoris and SW Persei. B. P. Gerasimovič. *Harvard Coll. Obs., Circ. No.* 338. *pp.* 1–9, *April* 24, 1929.

Both these variables are very peculiar, the first having a period of the unusual length of 72 days, and undergoing pronounced times of quietude when the brightness is equal to the faintest observed maximum and the brightest observed minimum. These stationary stages appear to occur periodically, unlike those of Z Leonis, which are quite irregular. No other stars have light-variations similar to these. The most remarkable feature in SW Persei is the changing period, which varies in length from 44 to 164 days. It is not of the RV Tauri type, and the only variable which resembles it is AF Cygni. M. A. E.

2713. Masses and Absolute Magnitudes of Binary Stars. J. H. Pitman. *Astron. J.* 39. *No.* 918. *pp.* 57–72, *April,* 1929.

The author reviews the history of this subject since 1923; Brill's and Eddington's methods agree for stars between 1/5 and 4 times the sun's mass. The present paper brings together all available data. Visual binaries are divided into three groups (containing 33, 20 and 51 stars respectively) according to the ratio of the probable error to the parallax. The individual results are plotted in two diagrams; there is a marked concentration of points representing stars of about the same mass and absolute magnitude as the sun. He compares the mass ratios obtained with those in Boss's Preliminary Catalogue; with Algol variables (for these, many are in fair agreement with Eddington's curve over a large range in mass and magnitude); and with spectroscopic binaries. These results are exhibited diagrammatically. In a final table, the results are collected. It is evident that there is a general decrease in mass from the "early" to the "late" spectral classes, and a greater decrease in absolute magnitude; if the stars brighter than 1·5 absolute magnitude had been tabulated separately from the fainter, the contrast would have been greater. For six planetary nebulæ he finds the average mass as 16·7 and the average absolute magnitude as 8·1. A. S. D. M.

LIGHT.

2714. New Method of Colour Reproduction. C. Nordmann. *Comptes Rendus*, 188. *pp.* 1160–1162, *April* 29, 1929.

The trichromatic colour process is criticised from the point of view of the small transparency of the filters, and that the wave-lengths 6300, 5280 and 4570 given by Maxwell for the fundamental sensations exclude the brightest part of the spectrum. A spectroscopic arrangement is described which permits of finding filters to give the same sensation as any given selected part of the spectrum. Superior results are claimed for the use of these. F. S.

2715. Reflection of Ultra-Violet Rays from Metallic Surfaces in Relation to their Micro-Structures. H. Kotô. *Kyoto Coll. Sci., Mem.* 12. *pp.* 81–96, *March*, 1929.

The arrangement for the experiments was the same as that used by Chikashige for visible rays, except that a quartz prism was employed in the spectrometer. A number of samples of different pairs of metals in varying proportions were prepared, and tested microscopically for their micro-structures. Curves for the intensity of reflection against the percentage of one of the two constituents were taken. In the case of Cu–Ag there is a break in this curve for the saturated solid solution (2 %) of copper in silver, and another break at about 10 % of silver in copper; no minimum occurs with the pure eutectic, such as is found with the visible and infra-red rays. With Cd–Bi there is no minimum at the eutectic point, but one is found nearer the Bi end of the curve. With Zn–Cd there is a maximum at 50 % Cd and a minimum at 95 % Cd; the pure eutectic is formed at 82·6 % Cd; this behaviour is quite abnormal. The Cu–Ni system shows a maximum at 40 atomic % of Ni. With Mg–Zn, where the compound $MgZn_2$ is formed with 84·32. % of Zn_2 and there are two eutectics, B with 51·7 % of Zn and D with 96·8 % of Zn, the curve shows maxima at B, D and the $MgZn_2$ points, with minima between them. H. N. A.

2716. Preparation and Optical Properties of Very Thin Films of Iron. M. Cau. *Ann. de Physique*, 11. *pp.* 354–449, *April*, 1929.

Thin films of iron on microscope cover-slips have been prepared by sublimation in a vacuum from an electrically heated wire, and by sputtering of an iron kathode in an atmosphere of hydrogen to prevent oxidation of the film. The optical density and the reflecting power of the two surfaces of the glass-metal slips were measured, as well as their optical and geometrical thickness, and the Kerr and Faraday effects. The layers obtained by distillation show a natural birefringence and dichröism; they are sometimes metallic in appearance, and sometimes glossy and variable. Their index of refraction is similar to that of the massive metal, but they are much more transparent. The sputtered layers, in spite of their variable crystalline structure and degree of surface-oxidation appear to have the same optical constants as the massive metal. The magneto-optical effects also reveal differences of constitution and of superficial layers, which in the case of glossy distillates are profoundly altered. The sign of the magneto-optical effects and their variations with wave-length and strength of field agree with those of earlier observers, but the more amorphous deposits are less magnetisable than the more compact crystalline metal. Measurements with transmitted light show a magnetic rotation increasing with the thickness and larger than that found by Kundt for electrolytic iron. The Kerr effects on the two surfaces of the metal tend as the thickness increases towards limits comparable with the values for massive iron; the rotation at the face in contact with glass is practically equal to the product of the rotation at the free surface by the index of the glass. The values of the Kerr effect calculated from the Faraday numbers agree with the values found experimentally, small discrepancies being explained by superficial changes in the film. T. M. L.

2717. Practical Method for Examination and Birefringence of Optical Glass. H. L. Tardy. *Rev. d'Optique*, 8 *pp.* 59–69, *Feb.*, 1929.

The author's aims are (1) the distribution of birefringence in the sample made visible at a glance; (2) the determination in a few seconds of its values at selected points; and (3) an easy method of tracing the curves of equal birefringence between the opposite sides of the specimen. In the apparatus used a beam of circularly polarised light passes through the specimen when illuminated uniformly, and is reflected back through the specimen, through an analyser, a quarter-wave plate, and so to the eyepiece. The theory and details of the method are explained and examples given of its use. A sample 7·6 × 7·2 × 1·3 cm. can be examined and the birefringence at any point found to about 0·005 in 15 seconds.

R. S. R.

2718. Kerr Effect in Viscous Liquids due to a Radio-Frequency Oscillating Field. S. C. Sircar. *Indian Journ. Phys.* 3. *pp.* 409–424, *March*, 1929.

The Kerr effect in viscous higher alcohols has been studied for a radio-frequency oscillating field. A peculiar kind of restoration of light between crossed Nicols is observed which is a phenomenon entirely different from the Kerr effect, and is most conspicuous in the region of frequencies in which there is strong electric absorption. The liquid becomes translucent in the electric field at such frequencies. The Kerr effect in undecyl alcohol is too small for observation in an oscillating field of wave-length 114 cm. showing the existence of a time of relaxation in the Kerr effect, which lies between 10^{-8} to 10^{-9} sec. for this alcohol. AUTHOR.

2719. Polariscope for Study of Elements of Large Size. A. de Gramont. *Rev. d'Optique*, 8. *pp.* 70–71, *Feb.*, 1929.

The author describes an apparatus by which specimens up to 20 cm. in diameter may be examined for strain and birefringence with uniform illumination. Instead of the usual Nörremberg polariscope the sample is examined directly with the help of Airy's rings produced by auxiliary lenses and mirrors. R. S. R.

2720. Simple Interferometer for Measuring Small Thick Films. H. Fromherz and W. Menschick. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 399–404, *April*, 1929.

A parallel beam of light from a tungsten filament lamp is reflected by a quartz plate placed at 45° to the beam on to a parallel-sided vessel which reflects at its front and back surfaces. Interference results, and the reflected light passes through the quartz plate and is focussed by a quartz lens on the spectrometer slit. The width of the bands depends on the distance apart of the reflecting surfaces and the refractive index of the material between them. The theory of the method is given and possible sources of error discussed. The refractive index can be found for the visible spectrum in the ultra-violet and in regions of anomalous dispersion with an accuracy of 1 to 2 %. R. S. R.

2721. Brightness of Methods of Illumination for Microscopes. H. Naumann. *Zeits. f. Instrumentenk.* 49. *pp.* 177–187, *April,* 1929.

The author establishes the factors upon which the brightness in the object plane of the microscope is dependent. For certain kinds of illumination, no increase of brightness above existing magnitudes is possible at present, this holding where the aperture for the light source imposes an upper limit on the aperture for the objective. This is the case for bright field illumination, and for illumination with a vertical source. With other methods of illumination, especially dark field illumination, much can be done by the suitable choice and use of the light source. A method is described by which in certain frequently occurring cases an increased brightness or a larger field for the same brightness is attainable without a greater expenditure of energy from a larger source of light. It is considered that empirical and experimental rather than mathematical methods will be necessary to explain certain facts and conditions existing in microscope illumination. R. S. R.

2722. Studies in Photographic Sensitivity. Parts III, IV and V. O. Masaki. *Kyoto Coll. Sci., Mem.* 12. *pp.* 107–134, *March,* 1929.

These papers deal with the sensitising action of previous exposure to a dim light, the desensitising action by previous fogging by X-rays, and the effect of heat on the absorption spectrum and the photoelectric conductivity of silver bromide. From studies of the phenomenon that faint spectral lines can successfully be developed out when a plate is previously exposed to a dim light, it is found that plates thus treated have a greater final density than that corresponding to the sum of the two exposures. Fogging before the main exposure is more effective than that made after, whilst this sensitising action gradually decreases with increase of time between the two exposures. Fogging due to red light produces the greatest sensitising action, this action decreasing through the visible spectrum towards the violet. Panchromatic plates show this sensitising action plainly, but for ordinary plates it is only slight. A fog impression produced by X-rays is not reversed by light, but the inertia of the plates is increased by such previous exposure to X-rays. The desensitising action is greater for plates fogged before the main exposure than for plates fogged afterwards, whilst a decrease of an equal amount occurs in the sensitivity of the plate to lights of various wave-lengths. This fogging action is independent of the time between exposures. The decrease in sensitivity is greatest for rapid plates, whilst the decrease can also be restored by a second fogging to dim light or *vice versa.* The effect of temperature on the absorption spectrum of silver halides is to displace the red end of the spectrum to the red side. With the application of heat the maximum point of the photoelectric conductivity curve of silver bromide is also displaced towards the same side. This appears to support the photoelectric conductivity theory of photographic action, the effect of heat on the absorption and photoelectric conductivity of silver bromide being similar to the way in which it affects the photographic action. [For Parts I and II see Abstract 1849 (1929).] R. C. F.

2723. Theory of Photographic Processes. H. Kieser. *Zeits. f. wiss. Phot.* 26. *pp.* 321–340, *April*, 1929.

The author further considers the chemical and physical secondary reactions of the inner photoelectric effect [see Abstract 2014 (1929)]. This gives rise to further possible explanations of the phenomenon of photolysis as well as for other important appearances of it. Considering the Einstein postulate, together with Fajan's conception of the inner photoelectric effect, it is found possible to offer explanations for the phenomena of solarisation, the Clayden effect, Schwarzschild's and intermittent illumination effects, dye sensitisation, desensitisation, and the Herschel effect, all of which are dealt with in detail. R. C. F.

2724. Photochemical Reaction between Mercury Vapour and Oxygen. W. A. Noyes, Jr. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 445–448, *April*, 1929.

Reference is made to the work of Leipunsky and Sagulin who investigated the same problem. In this paper a reaction mechanism is suggested which allows the observed results to be explained. The present investigator is in agreement with Leipunsky and Sagulin that the pressure of oxygen in a mixture of mercury vapour and oxygen diminishes when the mixture is subjected to the rays of a mercury lamp giving a wave-length of 2537, and that illumination gives a precipitate of mercury, the precipitate being thickest at the side of the reaction vessel nearest to the lamp. Differences arise between the investigators on the action of short wave-lengths. J. K.

2725. Integrating Photometer for X-Ray Crystal Reflections. W. T. Astbury. *Roy. Soc., Proc.* 123. *pp.* 575–602, *April* 6, 1929.

Gives theory and constructional details of an integrating microphotometer in which the photographic negative is replaced by a carbon print made from it. The α-ray penetration of this carbon print is then measured and direct proportionality is obtained between X-ray intensities used to make the original negative and the α-ray ionisations observed in the electroscope. Successful experimental tests on both real and artificial X-ray spots are described, and it is shown how the use of such an integrating microphotometer may be extended to the measurement of α-, β- and γ-rays, and also of visible light. The method may be applicable to the measurement of star intensities. W. H. Ge.

2726. Measurement of the Reflection of Light from Living Materials. L. A. Brunsting and C. Sheard. *J.O.S.A. and R.S.I.* 18. *pp.* 349–353, *April*, 1929.

Describes a modification of the Keuffel and Esser spectrophotometer whereby an examination of the light reflected from living materials can be carried out without any temperature effects taking place. It consists of a water cell in which are two small rectangular openings arranged one above the other, the water cell being attached to the instrument so that these holes occupy the same positions as the magnesium blocks normally used. The top opening can be used either for the material under test or for the magnesium block used for calibrating the standard magnesium block fixed in the lower hole. Felt is used to separate the test material from the water cell, thereby eliminating edge temperature effects. R. C. F.

2727. Phosphorescence and Photochemical Action of Some Organic and Inorganic Substances after Exposure to Ultra-Violet Light. F. Kirchhof. *Phys. Zeits.* 30. *pp.* 240–241, *April* 15, 1929.

A number of substances were experimented with, including " fluoren," a zinc organic salt, $BaPtCy_4$ (X-ray screen), a photoactive paper, the ashes of this paper, boric acid, calcium hypophosphite. Some of these showed phosphorescence, and some affected a photographic plate after illumination with ultra-violet light; others showed both phenomena. It appears that two distinctly different complexes are involved—visible phosphorescence, and the resulting photochemical after-action, which is of short duration, as in the case of " fluoren "; and an invisible, perhaps ultra-violet, radiation, which acts photochemically for a long period, as in the case of the X-ray screen. H. N. A.

2728. Duration of Afterglow Phosphorescence of I_2, K_2, Na_2, and Na Resonance Rays. H. H. Hupfeld. *Zeits. f. Physik,* 54. 7–8. *pp.* 484–497, 1929.

W. Wien has measured the time directly by the canal-ray method. The phosphoroscope method has been used by Wood, Wawilow and Lewschin [see Abstract 1319 (1926)]. The present author describes the experiments made with Gaviola's electro-optical phosphoroscope or fluorimeter. The principle of the fluorimeter is that of a Becquerel phosphoroscope in which the rotating discs are replaced by Kerr cells placed between crossed nicols. A high-frequency alternating current is applied to the Kerr cells, whereby an intermittent double refraction is produced. Nitrobenzene was used in the cells. Diagrams of the experimental arrangement of apparatus are given. The method described was suggested by Pringsheim for the measurement of the velocity of light. Karolus and Mittelstaedt [see Abstract 466 (1928)] have used the same method for measuring the velocity of light with great exactness. Full details of the experiments, together with an outline of the theory, are given. The results obtained were: for I_2, $t = 1\cdot10^{-8} \pm 1\cdot10^{-9}$ sec.; for K_2, $t = 8\cdot10^{-9} \pm 1\cdot5\,.\,0^{-9}$ sec.; for Na_2, $7\cdot5\,.\,10^{-9} \pm 1\cdot5\,.\,10^{-9}$ sec.; and for the D-line resonance radiation, $t = 1\cdot5\,.\,10^{-8} \pm 0\cdot3\,.\,10^{-8}$ sec. These values are compared with those of other authors and some existing discrepancies discussed. T. B.

2729. Raman Effect. B.Rossi. *N. Cimento* (*Rivista*), 6. *pp.* 61–69, *March*, 1929.

Summary and discussion of the various results obtained in this field.
A. D.

2730. Raman Effect in Crystals. H. Nisi. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 127–129, *March*, 1929. *In English.*

Observations on fluorspar, quartz, topaz and calcite were made, using a mercury arc and quartz spectrograph. No trace of Raman lines was found for fluorspar. Results are given for the other crystals, those of quartz agreeing well with Pringsheim and Rosen's results, those of calcite with Wood's, while those for topaz appear to be the only ones so far available. The Raman lines for topaz correspond to infra-red absorption bands at $11\cdot0\mu$ and $38\cdot5\mu$. F. S.

2731. Raman Spectra of Ionised Substances. R. G. Dickinson and R. T. Dillon. *Nat. Acad. Sci., Proc.* 15. *pp.* 334–337, *April*, 1929.

The Raman spectra of aqueous solutions containing respectively CO_3, ClO_3, BrO_3, IO_2, SO_3, HCO_3, SO_4 and ClO_4 ions have been investigated.

The magnitude of the frequency change in the Raman effect appears to be uninfluenced by the nature of the positive ion. Nitric acid solution gives the value $\Delta\nu = 1047$, in agreement with the value for nitrates. $\Delta\nu$ for SO_3 is the same as that for SO_4; ClO_3 gives the same value as ClO_4. $\Delta\nu$ corresponding to the strong line present decreases with increase in atomic number of the central atom of the negative ion. J. S. G. T.

2732. Formation, Pre-Dissociation and Dissociation of Molecules as Determined by Means of Vibration Spectra. Study of Sulphur Monoxide. V. Henri and F. Wolff. *J. de Physique et le Radium*, 10. *pp.* 81–106, *March*, 1929.

Gives a general account of the theory of molecular vibration spectra, the analysis of which spectra makes it possible to calculate the energy of normal dissociation of a molecule AB into two normal atoms, and the energy of activated dissociation where one or both the atoms are activated. It is shown that the correspondence between the vibrational levels of a normal molecule and those of an activated molecule makes it possible to fix the moment when the activated molecule passes into the state of pre-dissociation. Studies the emission spectrum produced by an oscillatory discharge in sulphur dioxide and shows that it is due to sulphur monoxide. The energy of dissociation of SO into the atoms S and O, calculated from the vibration spectrum, is 148,000 calories. Analysis of the rotation spectrum gives the approximate value of the moment of inertia $J_0 = 32 \times 10^{-10}$; the distance between S and O is equal to 1·34 Å. It is shown that on collision with an electron a molecule AB_2 is decomposed into an activated molecule AB^* and an atom B. AB^* then passes to the normal state AB, giving out the corresponding spectrum. H. N. A.

2733. Stark Effect for the Diffuse Lines of Silver and Lithium. R. H. Snyder. *Phys. Rev.* 33. *pp.* 354–360, *March*, 1929.

The Stark effects on the 5^2P_2–6^2D and 5^2P_1–6^2D groups of silver lines were studied experimentally. In the 5^2P_2–6^2D group the violet *s*-component was split into two branches, the stronger outer one being designated the $^2D_3$ branch and the weak inner one the F branch. The red *s*-component has only one branch designated $^2D_2$. The results fit better the assignment of Fujioka and Nakamura [*Astrophys J.* 65. p. 201, 1927] than did the previous results of Takamine [see Abstract 1396 (1919)]. In the lithium spectrum the line λ4602·51 Å. was resolved into three *s*- and three *p*-components with the violet side having a stronger outer and a weaker inner component for the *p*-vibration, and a weaker outer and a stronger inner component for the *s*-vibration. The line λ4132·93 Å. was resolved into three *s*- and three *p*-components. W. V. M.

2734. Zeemann Effect in the Ångström CO Bands. F. H. Crawford. *Phys. Rev.* 33. *pp.* 341–353, *March*, 1929.

A continuation of previous work [see Abstract 362 (1928)]. The experimental arrangements have been improved enabling greater intensities to be obtained as well as the elimination of impurities. Observations of the Zeeman effect have been extended from the bands at 5610, 5198 and 4835 to include 4511 and 4394. Measurements on thirty patterns with M = 1 (the ordinal number of the line in a branch) from fields from 18,000 to 36,000 gauss show widths of Zeeman patterns proportional to the fields strengths within the limits of experimental error. The weighted average of the pattern widths for M = 1 is $0{\cdot}977\ \Delta\nu_n$ and for M = 2 is

$0 \cdot 663\, \Delta\nu_n$, $\Delta\nu_n$ being the normal Lorentz triplet half width. Quantum mechanics predict $1 \cdot 00\, \Delta\nu_n$ and $0 \cdot 667\, \Delta\nu_n$ respectively as against $0 \cdot 889\, \Delta\nu_n$ and $0 \cdot 64\, \Delta\nu_n$ on the old quantum theory. The intensity asymmetries reported previously and later treated theoretically by Kronig [see Abstract 1617 (1928)] have been found to behave qualitatively but not quantitatively as the theory suggests. Eight isolated lines show anomalously large Zeeman effects. Three (and possibly four) new bands have been observed which belong to the Ångström group. W. V. M.

2735. New Band System of Carbon Monoxide ($3'S \rightarrow 2'P$) with Remarks on the Ångström Band System. R. C. Johnson and R. K. Asundi. *Roy. Soc., Proc.* 123. *pp.* 560–574, *April* 6, 1929.

Details are given of a new band system of CO corresponding to the electronic transition $3'S \rightarrow 2'P$. Four bands of the $n' = 0$ progression have been observed, the heads of which are at $\lambda\lambda 3680 \cdot 05$, $3893 \cdot 15$, $4125 \cdot 02$ and $4380 \cdot 18$. Fine structure analysis of the (0,1), (0,2) and (0,3) bands has been made. The structure is in every respect similar to the Ångström system, with which they share the final state in common. Combination defects are not apparent until high j-values are attained. The correct assignment of (half-integral) j-values has been applied to the Ångström system. Minor corrections have been made to Jassé's analysis of the (0,0) Ångström band. The state $n = 1$ of the $2'P$ level is believed to suffer a vibrational perturbation. W. H. Ge.

2736. Characteristic Vibrations of the CO_3 Group. C. Schaefer. *Zeits. f. Physik*, 54. 9–10. *pp.* 676–678, 1929.

Contains remarks on the views of Herzfeld. Shows that in his attempted explanation of the infra-red characteristic vibrations Herzfeld has confused wave-length and vibration frequency so that his suggestions have no weight. He has mentioned Aschkinaas as the first to show that the wave-length of the characteristic vibrations of a group does not alter greatly when the same ionic radicle is considered in a group of salts. The actual words used by Aschkinaas do not justify this statement. H. N. A.

2737. σ-Type Doubling and Electron Spin in the Spectra of Diatomic Molecules. J. H. van Vleck. *Phys. Rev.* 33. *pp.* 467–506, *April*, 1929.

The diatomic molecule with assumed stationary nuclei gives rise to spin multiplets. The theory of the distortion of these multiplets when the whole molecule is allowed to rotate is developed, together with the theory of " sigma type doubling " of spectral lines which is due to the removal of the degeneracy associated with the equality of energy in left- and right-handed axial rotations (electronic) in stationary molecules, when molecular rotation occurs. Pauli's scheme of two wave functions per electron is employed, and the results also hold in Dirac's quantum theory. The perturbing matrix elements due to components of angular momentum perpendicular to the nuclear axis (neglected in symmetrical top theory) are calculated. An interesting result that comes out in the analysis is that although orbital and spin angular momentum operators look superficially different, their gyroscopic effects enter additively as commonly supposed. It is found that (*a*) singlet P states should exhibit a sigma doubling proportional to $j(j+1)$, {j = rotational quantum number} and D states ordinarily a negligible doubling; (*b*) in ^2P states the spin profoundly modifies the sigma doubling; (*c*) " rho-type doubling " in ^2S states can be explained as due to superposition of the rotational distortion on the magnetic coupling between the components of spin and orbital angular momentum which are perpendicular to the nuclear axis. A summary of the results and a comparison with experimental data due to Mulliken [see next Abstract] is given. Striking agreement with theory as regards type of variation with j in the various cases is obtained. The theoretical orders of absolute magnitude are also confirmed. W. S. S.

2738. Electronic States and Band Spectrum Structure in Diatomic Molecules. VIII. Some Empirical Relations in σ-Type Doubling. R. S. Mulliken. *Phys. Rev.* 33. *pp.* 507–511, *April,* 1929.

Tables are given summarising the empirical results available concerning σ-type doubling. The magnitudes of the doublet intervals as a function of j and in relation to $\Delta E/B$ are considered, and the agreement with van Vleck's theoretical treatment [see preceding Abstract] discussed briefly. W. S. S.

2739. Band Systems in the Molecular Spectrum of Hydrogen. Part I. W. Finkelnburg and R. Mecke. *Zeits. f. Physik,* 54. 3–4. *pp.* 198–214, 1929.

Finkelnburg has recently published measurements of over 3600 lines between $\lambda 4861 (H_\beta)$ and $\lambda 3314$. The authors have endeavoured to work up theoretically this complicated spectrum, and the first part of their results is contained in the present paper. The measurements of Gale, Monk and Lee are also made use of. Richardson has already found a series of connected band systems, which include the Fulcher bands, and has named them α, β, γ, δ, and ε bands. The authors find that, with the exception of the ε system, Richardson's band systems are roughly speaking correct; but that except in the α system only a small part of the lines ascribed to the different bands really belong to them, great alterations being required, particularly in the γ and δ systems; the reality of the ε system has not been confirmed. The work has been carried out essentially with the help of the combination relations, since the branches in this spectrum are not generally parabolic in form. Mecke's alteration of intensity law and the temperature effect were also used in assigning lines to their places. 383 lines are arranged in four band systems, with 91 Q branches; 146 of these were already arranged by Richardson. Most of these lines are faint. H. N. A.

2740. Fulcher Bands of Hydrogen. I. Sandeman. *Roy. Soc. Edinburgh, Proc.* 49. 1. *pp.* 48–64, 1928–1929.

In view of the measurements of Gale, Monk and Lee the author has come to the conclusion that the Fulcher bands are capable of a somewhat simpler arrangement than that proposed by Richardson. The combinations found indicate that there are only three main branches associated with each band, which may be called the R′, Q and P′ branches; the Q branches are identical with those of Richardson. The arrangement is very similar to that proposed by Dieke, except that he gave no negative branches. The R′ and P′ branches have a common initial level, differing from that of the Q branch, while all three branches have a common final level. The arrangement yields term differences consistent throughout the bands. As far as these term differences have been investigated they have been found to be in agreement with the new mechanics. The paper contains a number of tables, with data concerning the lines forming the bands. H. N. A.

2741. Spectrum of H_2. Bands Analogous to the Parhelium Line Spectrum II. O. W. Richardson and P. M. Davidson. *Roy. Soc., Proc.* 123. *pp.* 466–488, *April* 6, 1929.

Continuing the previous paper [see Abstract 2494 (1929)], further band systems are described, including the system with P strong R weak, now called 3′A→2′S, and five systems, coming from electronic levels with principal quantum number 4, denoted by 4′A→2′S, 4′B→2′S, 4′C→2′S, 4′X→2′S and 4′E→2′S. The electronic terms are evaluated and a determination made of the ionisation potential of H_2, which is found to equal 15·381 volts, against 23·7 volts computed on the basis of the old quantum mechanics and 15·9 volts determined electrically. Values for the heat of dissociation ($4{\cdot}465 \pm 0{\cdot}04$ volts) of H_2 and for the heat of dissociation (2·50 volts), vibration frequency at zero amplitude ($\omega_0 = 2280$ wave numbers), and $x\omega_0(60)$ of the hydrogen molecule ion H_2^+ are obtained. Burrau's computations based on wave mechanics are shown to be consistent with these values. W. S. S.

2742. Continuous Spectrum of Hydrogen. D. Chalonge and M. Lambrey. *Comptes Rendus,* 188. *pp.* 1104–1106, *April* 22, 1929.

This is a continuation of previous work [see Abstract 2524 (1927)]. The greatest intensity was found with a pressure of 2–3 mms., and the intensity increased with the current through the discharge tube. Three different types of tube were compared and found to give similar results. The discharge has been compared with the positive crater of the carbon arc, and its use as a standard of intensity in the ultra-violet is suggested. F. S.

2743. Physical Criticism of Schrödinger's Theory of Light Emission. Parts I, II and III. J. Stark. *Ann. d. Physik,* 1. 8. *pp.* 1009–1040, *May* 7, 1929.

In Part I it is suggested that the agreement claimed between the observed intensity ratios for the Stark components of the hydrogen lines and those computed using Schrödinger's theory has not been satisfactorily established. Foster and Chalk [see Abstract 2497 (1929)] used the light emitted from a kathode layer in a lo Surdo tube to measure these ratios, but the author shows that owing to inhomogeneity of the field near the kathode this method is likely to give false results. The position taken up is that the intensity ratios of the Stark components of the lines H_α, H_β and H_γ are not constants characteristic of the hydrogen atom, but vary over a wide range with the conditions of measurement. In Part II Schrödinger's theory is objected to because of its inconsistence with the view that whenever emission or absorption of light occurs the smallest quantity of energy involved is related to the light frequency n by the equation $\Delta E = hn$. Part III. The difficulties of assuming the electronic charge in the hydrogen atom to be spread over the whole atomic domain and, when the atom is emitting, to be vibrating partly with one frequency and partly with another, are stressed. W. S. S.

2744. Intensity Measurements in the Helium Spectrum. D. Burger. *Zeits. f. Physik,* 54. 9–10. *pp.* 643–655, 1929.

The intensity relations of 56 helium lines are measured from photographs of the spectrum obtained with various exposure times and for two different tubes, the line 4026 Å. being used as the reference line. Only one line, 3889 Å. of the principal triplet series is included in the lines measured, whilst the wave-length range considered is from 7281 Å. to 3211 Å. It is found that the decrease in intensity of the lines in the principal singlet series is greater than that for lines in the near series, whilst in all the series the decrease is approximately the same as that found by Bongers for the Balmer series. According to theoretical considerations the ratio between the intensities of the lines in the singlet and triplet near series should be 1 : 3 when they are divided by ν^4, and for most of the lines examined in the diffuse series this was found to be approximately correct. The lines measured in the sharp series did not give such good agreement, and in both series this ratio was somewhat smaller with weak lines. R. C. F.

2745. Luminosity Duration for Helium Lines. R. v. Hirsch and R. Döpel. *Ann. d. Physik,* 1.7. *pp.* 963–976, *April* 19, 1929.

The Wien method for determining the luminosity decay time for the lines emitted by canal rays was used to determine the decay constants for ten helium lines. The disturbing effect of residual gas in the observation chamber may be expected to be greater for helium than in the case of hydrogen, as the helium canal rays and the helium molecules both consist of single atoms. Experiments using kathodes of different design showed, however, that for pressures below $2\cdot10^{-3}$ mm. no appreciable disturbance occurred (Wien gave almost exactly this value for the limiting safe pressure in his hydrogen measurements). The final mean values of the decay constants and times are given in the accompanying table:—

Line.	Decay Constant, α.	Decay Time, T.
2S–3P	$>25\cdot10^7$ sec.$^{-1}$	$<0\cdot4\ .\ 10^{-8}$ sec.
2S–4P	12·4 ,,	0·8 ,,
2P–4D	4·2 ,,	2·3 ,,
2P–5D	3·2 ,,	3·1 ,,
2P–6D	2·0 ,,	5·0 ,,
2*s*–3*p*	3·4 ,,	2·9 ,,
2*p*–4*s*	3·1 ,,	3·2 ,,
2*p*–3*d*	6·9 ,,	1·4 ,,
2*p*–4*d*	5·4 ,,	1·7 ,,
2*p*–5*d*	5·3 ,,	1·7 ,,

It is seen that, as for hydrogen, the decay constant is markedly different for different series. Furthermore, in contradistinction to hydrogen, the helium lines in a given series show a progressive change in the decay constant. W. S. S.

2746. Spectrum of Doubly Ionised Chlorine. K. Majumdar and S. C. Deb. *Indian Journ. Phys.* 3. *pp.* 445–450, *March,* 1929.

The work of Bowen [see Abstract 1283 (1928)] on the spectrum of doubly ionised chlorine has been extended and 30 further lines have been classified. They are attributed to the transition $2M_2(M_3\leftarrow N_2\leftarrow N_3)$. F. J. W.

2747. Spectra of As111 and Sb111. P. Pattabhiramiah and A. S. Rao. *Indian Journ. Phys.* 3. *pp.* 437–444, *March*, 1929.

Forty-one lines of As111 and twenty-five lines of Sb111 have been classified. Other combinations involving the characteristic difference 722 in arsenic and 1668 in antimony are tabulated. Further tables are given of the relativity doublet law variations in gallium-and indium-like atoms, and the term values for these types are compared. [See Abstracts 643 and 3034 (1928).] F. J. W.

2748. Band Spectrum of Fluorine. H. G. Gale and G. S. Monk. *Astrophys. J.* 69. *pp.* 77–102, *March*, 1929.

Smythe attributed this band to CF_4, but the authors negative this result after repeated trials with good photographs of large dispersion (2·63 Å. per mm.); they describe their apparatus and find two conditions for the appearance of the bands: (1) a continuous flow of fresh fluorine from the generator, and (2) a discharge of low current density; the spectrum of iron was used for standard comparison, and the measurements were to thousandths of a millimetre on a Gaertner comparator and are accurate (except for the faintest bands) to 0·05 Å. The two bands yielding most easily to analysis are $\nu_0 = 17{,}439 \cdot 5$ and $\nu_0 = 16{,}378 \cdot 8$ (shown on a plate), and weaker bands are at $\nu_0 = 15{,}337 \cdot 6$, $\nu_0 = 17{,}075 \cdot 9$, and $\nu_0 = 18{,}548 \cdot 4$. Each band seems to consist of a series of doublets whose components are of unequal strength, with many fainter lines which are not obviously connected in typical branches. They describe their attempts to assign these faint lines to positions on the three identified branches; each band contains three branches, a strong Q, a weak P and a weaker R. Certain characteristic perturbations allowed the assignment of *j*-values by supposing that the perturbations are connected with the initial state, so that $R_j - Q_{j+1} = Q_j - P_{j+1}$ approximately. For lines near the band head, $R_j \times P_j = \Delta_2 F'(j)$ are the same for different bands with the same initial vibrational state, and for the strong branch lines account must be made of the total intensity of a composite line. It has not been possible to give extensive data for the quantum defect. The analysis of the bands give $B_0' = 0 \cdot 815$, $B_0'' = 1 \cdot 073$ and from these values are got the moments of inertia for the initial and final states of the F_2 molecule, and the internuclear distances as: $I_0' = 34 \cdot 2 \times 10^{-40}$; $I_0'' = 26 \cdot 0 \times 10^{-40}$; $r_0' = 1 \cdot 48 \times 10^{-8}$ cm; $r_0'' = 1 \cdot 28 \times 10^{-8}$ cm. A. S. D. M.

2749. 3d-Orbit in Ionised Atoms PII, SII, SIII and ClIII. J. Gilles. *Comptes Rendus*, 188. *pp.* 1158–1160, *April* 29, 1929.

The 3*d*-orbit has been shown to be close to the 4*s*-orbit in SII and SIII, while it is the normal distance PII which should correspond to SIII. A number of quadruplets of ClIII are given, involving 3*d*- and 4*p*-orbits. It seems that the 3*d*-orbit varies between the 4*s* and 4*p* as we pass from P to Cl, and that the errors of the 3*d* terms are normal for these elements, but that the 3*d* and 4*s* nearly coincide for SIII. F. S.

2750. Absorption Band Spectrum of Chlorine. A. Elliott. *Roy. Soc., Proc.* 123. *pp.* 629–644, *April* 6, 1929.

The absorption spectrum of chlorine consists of a continuous absorption from 2300 Å. to about 5000 Å. and a feeble band absorption in the region 4785–6220 Å. The latter has been investigated by a number of workers, and the author has used tubes 1·6 m. long filled with chlorine at 1 and 2 atmospheres pressure. The spectrum was photographed with a 21-ft.

grating. Analysis of three bands shows that only P and R branches exist. Measurement of the isotope effect has made it possible to assign vibration quantum numbers for the excited state. Bands due to $Cl_{35}Cl_{35}$ show an alternation of 1·4 : 1 in intensity of the band lines. This is not present in bands due to $Cl_{35}Cl_{37}$. These two molecules have different moments of inertia but equal internuclear distances. F. S.

2751. Arc Spectrum of Silicon. A. Fowler. *Roy. Soc., Proc.* 123. *pp.* 422–439, *April* 6, 1929.

By passing an arc in nitrogen at atmospheric pressure and using a vacuum grating spectrograph, the arc spectrum of silicon has been photographed to about λ1600. Many previously unrecorded lines have been observed and the analysis of the spectrum greatly extended. Most of the deeper terms predicted by Hund's theory have been identified, and several sequences of singlet and triplet combinations are available for the determination of term values. The ionisation potential is calculated to be 8·12 volts. Comparison is made with the spectrum of singly ionised phosphorus and the expected similarity found. F. S.

2752. Absorption Spectrum of Lithium Hydride and the Molecular Constants of LiH. G. Nakamura. *Zeits. f. phys. Chem.* 3. *Abt. B. No.* 1. *pp.* 80–82, *April,* 1929.

Preliminary notice. The only work on the spectrum of LiH is that of W. W. Watson [*Phys. Rev.* 25. p. 887, 1925]. Emission photographs of a lithium arc in hydrogen confirm Watson's results. Fortunately the author was able to photograph the absorption spectrum whereby the key to the arrangement of the band spectrum was obtained. Under the conditions of the experiment, a large number of absorption lines were observed between 3100 and 4500 Å. These covered the emission lines found by Watson. A curve is given showing the relation between nucleus distance and atomic number for the hydrides of the elements of the second period. T. B.

2753. X-Ray Optics. W. L. Bragg. *Brit. J. of Radiology,* 2. *pp.* 65–71; *Disc.,* 71–73, *Feb.,* 1929.

An extremely lucid account of the processes of image formation in a microscope using ordinary visible light, and a discussion of the difficulties which arise in any attempt to use X-rays in a similar manner. The relative "sizes" of X-rays and molecules, however, make it possible to "see" the shapes of these structures though the eye has to be replaced by a complex apparatus both instrumental and mathematical. The Abbé theory of the high-powered objective when viewing a regular structure is then discussed in terms of the formation of diffraction spectra as the first stage in image formation, the spectra of various orders being recombined to give the image proper. The effects of including spectra only up to the 1st, 2nd, 3rd . . . orders are discussed, and the way in which the image becomes a more faithful representation of the object by the inclusion of higher orders is indicated. The X-ray case is then examined and it is shown that the spectra are formed in exactly the same way in normal crystal analysis, but the problem of recombination is more difficult but may be carried out artificially as follows. By means of a projection lantern one can throw on a screen a series of interference bands, or diffraction bands, of black and white. A large size sheet of sensitive paper is pinned on a drawing-board, and for each pair of spectra obtained from X-ray measurements of a zone of a crystal (actually diopside), a corresponding interference band is thrown on the paper in the correct position for that particular pair and exposed for a time corresponding to the measured strength of the spectra. In an example reproduced forty such bands were thrown on to the sheet. The result is a clear image of the crystal viewed along the zone axis to which the spectra correspond, and we have a real image of the crystal as " seen " in an X-ray microscope, individual atoms being clearly visible. The result is shown to agree very well with the results of the usual type of analysis. W. V. M.

2754. Polarisation in the Compton Effect. P. Lukirsky. *Zeits. f. Physik*, **53.** 11–12. *pp.* 792–804, 1929.

The theoretical consideration of the Compton effect leads to the conclusion that with decreasing wave-length of primary radiation the probability of Compton scattering as opposed to " classical " scattering is increased, so that the scattering of hard rays is almost entirely according to the Compton rules. Measurements made by the author on the scattered radiations from a paraffin sphere when rays of wave-lengths 0·1 Å. fall on it give an increase in wave-length of 0·022 Å. The Compton theory predicts a shift of 0·0243 Å., and it may therefore be concluded that the scattering is almost entirely a Compton process. Investigation of the scattered secondary radiation (tertiary radiation) shows that this radiation is strongly polarised in a manner which would be predicted by classical theory, and it is deduced that the intensity of the Compton radiation in a given direction depends on the projection of the electric vector in that particular direction. The recoil electrons corresponding to the Compton process must therefore have a favoured direction which should lie in the plane of the magnetic vector. Kirchner has discovered such an effect, but the experimental conditions allow of only a qualitative comparison. The quantitative solution should be sought in investigations of the scattering of linearly polarised γ-rays in Wilson expansion chambers. W. V. M.

2755. Classical Derivation of the Compton Effect. C. V. Raman. *Indian Journ. Phys.* 3. *pp.* 357–369, *March*, 1929.

With the aid of an atomic model in which the electrons are regarded as a gas distributed in a spherical enclosure surrounding the nucleus, it is shown that the classical wave-principles lead directly to a quantitative theory of the Compton effect and an explanation of the known experimental facts in connection with it. AUTHOR.

2756. Nature of Dextrin, Gelatin and Sodium Oleate Solutions by X-Ray Diffraction. P. Krishnamurti. *Indian Journ. Phys.* 3. *pp.* 307–329, *March* 31, 1929.

The X-ray diffraction of dextrin, gelatin and sodium oleate has been studied in the solid state and in aqueous solutions of varying concentrations. Dextrin gave patterns similar to those obtained from sugar solutions [see Abstract 1222 (1929)]. The molecular weight calculated from the extent of the gaseous scattering is about 600. Gelatin solutions were similar to those of dextrin. The molecular weight is calculated to be 3000, a value which is to be associated with the smallest particles of the solution since it was obtained from measurements of the outer edge of the diffraction disc. In both dextrin and gelatin solutions there is very little arrangement of the solute molecules. The patterns obtained from sodium oleate solutions were quite different in that even in fairly dilute solutions (1 : 10) the solute gives rise to a diffraction ring which is almost the same size as that obtained from the solid. It is suggested that this ring is due to the existence in the solutions of molecular micelles $(NaOl)_x$, which are built up of groups of molecules arranged parallel to one another. F. J. W.

2757. X-Ray Diffraction in Liquid Mixtures. P. Krishnamurti. *Indian Journ. Phys.* **3.** ***pp.*** **331–335, *March*, 1929.**

The X-ray diffraction patterns of phenol, trimethyl carbinol, piperidine, pyridine, butyric acid, ethyl alcohol, glycerine, and lactic acid have been photographed in the pure state as well as in aqueous solutions of varying concentrations. Dilute solutions gave, besides the normal water diffraction ring, a certain amount of general scattering. The more concentrated solutions are divisible broadly into two classes. In the first class, which includes phenol, trimethyl carbinol and piperidine solutions, the diffraction rings due to the two components are obtained almost undisplaced. Glycerine, ethyl alcohol and lactic acid solutions, which belong to the second class, give only one diffraction ring. Pyridine and butyric acid solutions appear to form a transition group between these two classes. Of the non-aqueous systems examined, methyl salicylate–*o*–nitrobenzaldehyde, and aniline–cyclohexane belong to the first class. On the other hand, in the cyclohexane–methyl salicylate system a considerable amount of general scattering was found, and the cyclohexane diffraction ring was displaced. It is suggested that in the first class the attraction of like molecules for each other predominates, with the resultant formation of molecular aggregates containing the same type of molecules. [Compare sodium oleate solutions of preceding Abstract.] In the second class, molecular aggregates of unlike molecules are formed owing to the attraction between solvent and solute molecules. F. J. W.

2758. X-Ray Diffraction in Liquids of the Terpene Series. V. I. Vaidyanathan. *Indian Journ. Phys.* 3. *pp.* 371–389, *March*, 1929.

The X-ray haloes given by 21 liquids of the terpane series were studied, using CuKα radiation. The various members of the long chain, cyclic and sesqui-groups have about the same diameter, although this increases from group to group, being about 4·95 Å. for the long chain compounds, 5·45 Å. to 6 Å. for the cyclic and 7 Å. for the sesqui liquids. The results are discussed in relation to the chemical relations of the liquids. F. S.

2759. Influence of Temperature on X-Ray Liquid Haloes. V. I. Vaidyanathan. *Indian Journ. Phys.* 3. *pp.* 391–398, *March*, 1929.

The haloes have been studied in five liquids at two different temperatures. An increase in the scattering at small angles, a contraction of the haloes and an increase in their diffuseness have been observed in all cases with rise of temperature. In the case of liquids with two haloes, the separation of the two tends to be effaced, and the inner haloes become diffuse more quickly than the outer ones. The results are interpreted on the basis of the theory of Raman and Ramanathan [see Abstract 1189 (1924)]. F. S.

2760. X-Ray Diffraction in Liquid Alloys of Sodium and Potassium. K. Banerjee. *Indian Journ. Phys.* **3.** ***pp.*** **399–408, *March*, 1929.**

The X-ray haloes in a series of liquid alloys were studied. The alloy is regarded as a solution of an excess of either metal in Na_2K, and the results discussed in accordance with Krishnamurti's results [see Abstract 178 (1929)]. When the amount of metal dissolved is small, the halo is nearly the same as for Na_2K, but when a metal preponderates the halo is nearly that of the metal. From the size of the halo for Na_2K, it is deduced that the atoms are at the corners of a triangle. F. S.

2761. Diffraction of Waves by Crystals. K. K. Darrow. *Bell System Techn., J.* 8. *pp.* 391–428, *April*, 1929.

This is an elementary introduction to the phenomena of diffraction of waves by crystals, one of the most striking and important discoveries of the last twenty years of physics. These phenomena have proved that X-rays and electrons are partly of the nature of waves, and have supplied the best available methods of measuring their wave-lengths; while, on the other hand, the study of the diffraction-pattern of a crystalline substance makes it possible to determine the arrangement and the interrelations of the atoms with a precision and fullness heretofore unimagined, which has already yielded knowledge of great value in all the fields of science and promises immeasurably more. AUTHOR.

2762. Preliminary Report on the Measurement of the Kα Line of Carbon. C. E. Howe. *Nat. Acad. Sci., Proc.* 15. *pp.* 251–253, *March*, 1929.

The measurements were made by reflection at grazing incidence from a ruled grating in a vacuum spectrograph. The lines were recorded on two parallel photographic plates, one near the grating and the other at a greater distance. The distance between the plates was measured, and the distance from the grating could be calculated from the geometry of the arrangement. The unweighted mean of the measurements gives the value 44·60 Å., with a probable error not greater than 0·04 Å. Thibaud's value is 44·9 Å., but the difference is approximately equal to his maximum possible error. Weatherby's value is 45·4 Å. H. N. A.

2763. Photographic Measurement of the Relative Intensities of Lα_1, Lα_2, Lα_3 Lines of Silver. H. C. Webster. *Phys. Soc., Proc.* 41. *pp.* 181–191; *Disc.*, 191, *April*, 1929.

Shows from a discussion of the relative advantages of the ionisation, Geiger counter and photographic methods of measuring X-ray line intensities that the photographic method possesses the advantages that a permanent record is obtained and that the photographic effect is cumulative. The disadvantages are the difficulty of deducing the intensity from the blackening of the emulsion and the care needed in development and photometry. In the author's method the Moll microphotometer is used to measure the densities, D, of the images of the lines produced by a vacuum spectrograph. This density is a function of the exposure, the frequency, the emulsion and the development, and it is shown that, from previous work, the Bunsen-Roscoe reciprocity law applies for X-rays. For constant development and for the range of frequencies measured D is shown to be a function of the number of quanta absorbed per second in the emulsion and the exposure time, this function being obtained by varying the exposure time, corrections being made for the overlapping of the lines. Results for the relative intensities obtained are Lα_1 : Lα_2 = 100·0 : 12·0; Lα_1 : Lα_3 from 100·0 : 4·6 to 100·0 : 7·3 dependent on the tube voltage. A value for the ratio of Lα_1 to Lβ_1 is also given as 100·0 : 40·0, but this is not so accurate as for the Lα lines. R. C. F.

2764. Spark Satellites of the Lα Lines of Silver. H. C. Webster. *Phys. Soc., Proc.* 41. *pp.* 192–193, *April*, 1929.

The results for spark satellites of the Lα lines of silver, measured by a relative method from $L\alpha_2$, are found to be $\alpha_2' = 4134\cdot7$, $\alpha_1' = 4130\cdot5$, $\alpha_2'' = 4125\cdot6$, and $\alpha_1'' = 4119\cdot0$ XU. The notation is that used by van der Tuuk [see Abstract 2078 (1927)]. The decreasing order of intensities of the lines is α_1', α_1'', α_2'', α_2'. R. C. F.

2765. X-Ray Spectrometric Measurements of the M-Absorption Spectra of the Elements Uranium to Tungsten. E. Lindberg. *Zeits. f. Physik*, 54. 9–10. *pp.* 632–642, 1929.

The absorption edges M_V, M_{IV} and M_{III} have been measured, of the elements uranium, thorium, bismuth, lead, thallium, mercury, gold, platinum and tungsten, using the latest type of Siegbahn vacuum spectrograph. There is a systematic deviation of the calculated from the observed values, particularly in the case of the M_{IV} and M_V absorption edges. The D/R values for the N levels of the above elements have been calculated from the values for the M absorption edges and the earlier determined M emission spectra [see Abstract 185 (1929)]. F. J. W.

2766. X-Ray Luminescence of Mercury Vapour. S. Mrozowski. *Zeits. f. Physik*, 54. 5–6. *pp.* 422–426, 1929.

Describes some spectroscopic observations on the radiation sent out by mercury vapour through which X-rays were passed. Differences had been found by other observers between such radiation and the fluorescence produced by visible and by ultra-violet light. The author concludes that there are real differences, and that with X-rays the principal effect is not one of direct X-ray fluorescence, but that both the visible and ultra-violet spectra produced are excited by slow photoelectrons split off from the mercury atoms by the X-rays. The spectrum is similar to the mercury arc spectrum, which is produced by numerous collisions of slow electrons with the atoms, with relatively high vapour density. H. N. A.

2767. X-Ray Intensity Maxima in Liquids. H. Mark. *Zeits. f. Physik*, 54. 7–8. *pp.* 505–510, 1929.

The Ehrenfest-Keesom formula for a diatomic gas is considered and shown to lead to an expression which only differs by a factor of 1·03 from that obtained for cubical and closest hexagonal crystal packings respectively. F. S.

2768. Fine Structure Absorption Edges of Metals and Metalloids for Röntgen Rays. B. Ray and P. C. Mahanti. *Zeits. f. Physik*, 54. 7–8. *pp.* 534–536, 1929.

Discusses the nature of the fine structure absorption edges of metals and metalloids in the Röntgen ray region, assuming the existence of free electrons in metals and also considering multiple absorption. The elements vanadium, chlorine and sulphur are specially considered. R. C. F.

2769. Determination and Production of Isohomogeneous X-Rays. N. Mirolubow and J. Poroikow. *Zeits. f. Physik*, 54. 5–6. *pp.* 399–407, 1929.

For biological work the degree of homogeneousness of the X-rays employed is important, and the authors propose to call beams containing the same number of octaves isohomogeneous. They give a method for

calculating the strength of the preliminary filter of suitable material for obtaining rays sufficiently homogeneous for use with a given absorbing medium. The results of calculations agree with experimental data.
H. N. A.

2770. Design of Low Voltage X-Ray Tube. E. Dershem. *J.O.S.A. & R.S.I.* 18. *pp.* 127–130, *Feb.*, 1929.

A description of a hot kathode X-ray tube suitable for investigations of long wave phenomena. It is essential that such a tube should be capable of carrying large currents below, say 25 kV, and should operate at a vacuum obtainable without costly pumping equipment. The electrodes of such an X-ray tube should therefore be close together, since this increases the sparking potential, experiments showing that at pressures from 0·002 to 0·01 mm. Hg. the spacing should be approximately ⅛ inch. Detailed dimensions of the tube are given and instructions for its assembly. The saturation current at 1000 volts is 200 m.a. W. V. M.

2771. Circuit Breaker for Water-Cooled X-Ray Tubes. L. W. McKeehan and L. M. Kirkpatrick. *J.O.S.A. and R.S.I.* 18. *pp.* 342–343, *April*, 1929.

A circuit-breaker for the protection of water-cooled X-ray tubes where the pressure of the water supply is low or fluctuating is described. It consists of a balanced bucket into which the exit water passes, so arranged that stoppage or diminution in the supply causes the counterpoise to decline and so break contact. Total stoppage effects this in 5″, a less drastic reduction in flow in a longer time. C. A. S.

2772. Spectrum Emitted by a Carbon Plate under Bombardment. A. A. Newbold. *Phil. Mag.* 7. *pp.* 706–719, *April*, 1929.

Describes an electrostatic method of investigating soft X-ray spectra. The carbon plate was bombarded by electrons with the velocity produced by an accelerating potential of 600 volts. The radiation from the carbon fell on a copper electrode producing photoelectrons; this electrode was connected to one pair of quadrants of an electrometer. The ratio between the photoelectric current and the thermionic current which produced the original bombarding electrons was plotted against the retarding potential applied to the photoelectrons, and the positions of the kinks in the resulting graphs were determined. These were ascribed to characteristic radiations emitted by the carbon plate. Over the frequency range 5700 to 26,000 the spectrum deduced is either identical with, or at least resembles very closely, that obtained by Millikan and Bowen for gaseous carbon.
H. N. A.

2773. Superposed X-Radiations. C. G. Barkla and M. M. Sen Gupta. *Phil. Mag.* 7. *pp.* 737–742, *April*, 1929.

It has been shown by Barkla and Mackenzie that the superposition of a beam of X-rays X on another beam Y gave a different J-discontinuity from either of the two beams. These experiments continue this work, and it is found that the absorption of a given radiation in the neighbourhood of a J-discontinuity is dependent on other radiations traversing the absorbing substance. The experiments have been confined so far to radiations scattered by the same substance from the same primary beam and differing little in path. J. E.

RADIOACTIVITY.

2774. Estimation of the α-Radiation of the Active Deposit of Actinium by Measuring its β-Radiation. Nahmias. *Comptes Rendus*, 188. *pp.* 1165–1167, *April* 29, 1929.

In certain cases the α-radiation is too strong to be conveniently measured, and it is impossible to spread the product into such thin films that the α-rays all escape without being absorbed in the material itself. Results can then be obtained by measuring the β-radiation. The author has experimented with actinon (actinium emanation), and activated a foil with it. The α-radiation of the active deposit is due to Ac.C, and almost all the β-radiation comes from Ac.C″. The saturation current due to the β-rays, I_β, is first measured and, when the decay has proceeded so that only about 1/20 of the activity remains, that due to the α-rays, I_α, is measured. From the rate of decay the ratio between the α- and β-rays at a given moment is calculated. $I_\alpha = 270\, I_\beta$. The ratio between the total α-radiation of all the bodies of the actinium family in true equilibrium with Ac.C is 4·89 times that of the Ac.C, so that the saturation current corresponding to the total α-radiation is 1320 times that measured for the β-radiation. **Errata,** *ibid.*, p. 1276, May 6, 1929. H. N. A.

2775. Groups of Radioactive Atoms. H. Jedrzejowski. *Comptes Rendus*, 188. *pp.* 1043–1045, *April* 15, 1929.

Miss Chamié's photographic method has been employed; thin layers of mica were activated in different ways, and then pressed with a weight of 10 kilos between two photographic plates. Activation by the α-recoil of RaB when RaA disintegrates gave numerous groups on the mica, activation by the β-recoil of RaC when RaB disintegrates *in vacuo* gave rarer groups, which, however, were very distinct. Images obtained from sources prepared by distillation show no groups, as these are destroyed during the evaporation of the active deposit. Heating for fifteen minutes to 350° C. did not affect the groups of atoms. H. N. A.

2776. Conditions of Formation of Groups of Radioactive Atoms. H. Herszfinkiel and H. Jedrzejowski. *Comptes Rendus*, 188. *pp.* 1167–1169, *April* 29, 1929.

The atoms of an active deposit have been distilled on to the surface of various liquids, including water, HCl and Hg, in the hope that groups of atoms would be formed. In one method the liquid was placed on a thin film of mica, and after the distillation the liquid was evaporated off, either in a current of hot air or at ordinary temperature in a vacuum. The mica films were then photographed by Chamié's method, and groups of atoms were observed when no special precautions were taken about the mica films. Using freshly split mica films, however, no groupings were observed when water was employed, while marked fluctuations in the distribution of the active deposit appeared in the majority of cases with HCl. It was shown that groups of atoms in a solution are not the cause of the activation of the filter paper when the solution is filtered, and that groups of atoms are not driven into mica by radioactive recoil when it is activated by radons, but that they remain fixed on the surface. H. N. A.

2777. β-Recoil. L. Wertenstein. *Comptes Rendus*, 188. *pp.* 1045–1047, *April* 15, 1929.

Studies the β-recoil of RaC expelled from RaB. The RaB sources prepared in different ways were deposited on different metals, and the RaÇ was received on different metals. The sources were in some cases heated to about 250° C., and the receiver was sometimes cooled to the temperature of liquid air. Heating the source diminishes the output. Only sources prepared by distillation give pure RaC; in other cases RaB is also found on the receiver. The output depends on the nature of the metal on which the source is deposited and on that of the receiver; details are given. Clean metal surfaces are necessary for good results. The maximum output obtained with Bi as receiver and Al as source was about 20 % (RaC is an isotope of Bi); Donat and Philipp only got an output of 2 to 6 %. H. N. A.

2778. Number of High-Velocity β-Rays. H. M. Cave. *Cambridge Phil. Soc., Proc.* 25. *pp.* 222–224, *April*, 1929.

A thin walled glass tube containing radon was placed between the pole pieces of an electromagnet; between the tube and the electroscope of thin aluminium was placed a cylinder of lead, which absorbed the softer γ-radiations. β-rays were bent by the magnetic field, and matters were arranged so that none of the β-rays of the ordinary well-known RaB + C spectrum with high-frequency limit could reach the electroscope; but the high-velocity rays observed by Yovanovitch and d'Espine were still able to do so. With a still higher field these could also be bent away. Allowing for ionisation due to γ-rays from the source, no effect that could be ascribed to the very fast β-rays could be observed. There are certainly fewer fast β-rays than 1 per 500, and probably fewer than 1 per 1000 disintegrations. H. N. A.

2779. Technique of Measuring Penetrating Radiations. G. Guében. *Ann. Soc. Sci. de Bruxelles*, 49. *pp.* 12–17, *April*, 1929.

The author draws attention to a source of error sometimes forgotten in the measurement of penetrating radiations, namely, the conductance of insulating materials under the action of such rays. In the use of standard ionisation chambers the insulation is normally withdrawn from the direct beam of rays, but in the construction of small ionisation chambers of the " fingerstall " type this is not the case. The insulating material near the chamber may be protected with heavy lead casing or simply filled with solid dielectric exposed to the rays; in the second case, although directional and secondary effects are avoided, the conductance of the insulating material is altered and affects the indications of the instrument. Various instruments in current usage are discussed, and the paper concludes with a description of some experiments made by the author on the conductance of insulators under the action of γ-rays. It is found that the conductance of ceresin increases for two or three hours after the commencement of irradiation, and reaches a maximum conductance of the order of one hundred times that originally possessed. The effect gradually disappears with the cessation of irradiation, some twenty-four hours being required for the return to approximately normal conditions. The influence of such variations on precise measurements of X-rays and γ-rays is emphasised. W. V. M.

HEAT.

2780. Recent Dilatometric Investigations. M. Haas. *Zeits. f. Metallkunde*, **21.** *pp.* **58–62**; *Disc.*, **62–63**, *Feb.*, **1929.**

Brief notes are given on recent dilatometric work on alloys at the Institut für Metallhüttenkunde und Elektrometallurgie, Aachen. The latest mechanical dilatometer of the Chevenard type is found to be sufficiently sensitive. A number of differential dilatometer curves for aluminium-silicon, aluminium-copper, aluminium-magnesium alloys, etc., are reproduced. T. H. P.

2781. Thermal Expansions of Mercury and Vitreous Silica. F. J. Harlow. *Phil. Mag.* **7.** *pp.* **674–685**, *April*, **1929.**

From experiments by the author himself and others the most probable values of the thermal expansion of vitreous silica and of mercury are considered over the range of temperature 0° to 300° C. The coefficient of cubical expansion of silica in this range of temperature is closely represented by the equation $S_0^t \times 10^{-8} = 198 \cdot 9 - 11{,}637/(t + 103)$, or by the quartic equation $V_t/V_0 = 1 + 10^{-8}(93 \cdot 6t + 0 \cdot 7776t^2 - 0 \cdot 003315t^3 + 0 \cdot 000005244t^4)$, which represents the variation in volume of an isotropic vitreous silica bulb over the range 0° to 300° C. A similar equation representing the true volume of mercury at these temperatures is

$$Vt/V_0 = 1 + 10^{-8}(18{,}153 \cdot 8t + 0 \cdot 7548t^2 + 0 \cdot 001533t^3 + 0 \cdot 000006732t^4).$$

A table of values of the volume of 1 cc. of mercury at 0° C. when measured at various temperatures from 0° to 300° C. is given, and is closely represented by the equation $V_t/V_0 = 1 + (a + b/(c - t)) \times 10^8$, values of a, b and c being respectively 17,539·1, 369,555 and 634·7. T. B.

2782. Measurement of Flame Temperatures. E. Griffiths and J. H. Awbery. *Roy. Soc., Proc.* **123.** *pp.* **401–421**, *April* **6, 1929.**

A working definition of the temperature of a flame is taken as "the temperature of a solid body which is in thermal equilibrium with the flame." Two methods of measuring a flame temperature are described. In the first, the "wire method," a platinum (or rhodium) wire, through which a measured variable current is passed, is placed in the flame and the temperature of the wire for various currents measured by an optical thermometer. The wire is removed from the flame and placed under an exhausted bell jar, and the measurements of temperature and current repeated. On plotting the two curves connecting current and temperature of wire, they meet at a point which is the true temperature of the flame. This follows from the fact that at this temperature there is no interchange of heat between wire and flame, *i.e.*, they are in "thermal equilibrium." Using a Meker burner as source of heat it was found that wires of very different diameter agreed in assigning the same temperature. The second method described is that of "spectral line reversal." An image of the incandescent sphere of a pointolite lamp is focussed through the flame on to the slit of the spectroscope, the flame being coloured with sodium chloride. The current in the tungsten arc is adjusted until the sodium lines just merge into the continuous background. The temperature of the incandescent sphere, as observed on the pyrometer, is then the same as that of the flame. The two methods give identical results within errors of experiment. The method of the sodium line reversal has also been used by the authors to determine the maximum temperature in gaseous explosions. T. B.

2783. Calculations on Screens used in Optical Pyrometry and their Experimental Verification. W. de Groot. *Rev. d'Optique,* 8. *pp.* 49–58, *Feb.,* 1929.

The paper is largely a theoretical study of formulæ for use with screens. While considering the transmission coefficient of a coloured screen as a function of wave-length, the reciprocal of the effective wave-length is calculated as a function of the reciprocal of temperature, the results being expressed (1) in the form of a series and (2) in the appropriate graphical form. Employing the coefficient of transmission of an absorbing screen given by $Ae^{-\beta/\lambda}$, a solution is found for the apparent black body temperature of a source for a given mean wave-length for an optical pyrometer fitted with such a screen. The determination of the effective wave-length by a direct method is discussed, and also a method for the comparison of two coloured screens. R. S. R.

2784. Boiling Points of Aqueous Solutions. W. D. Bancroft and H. L. Davis. *J. Phys. Chem.* 33. *pp.* 591–604, *April,* 1929.

The Washburn and Read modification [see Abstract 1125 (1919)] of the Cottrell apparatus for measuring the boiling point elevation of solutions is found to be ineffective in removing the superheating of water, when this is used as solvent. A method for detecting such superheating is described, as also is a new modification of the Cottrell apparatus which is capable of obviating superheating and thus renders possible the determination of the boiling points of dilute aqueous solutions. Experiments with dilute solutions of potassium nitrate and the potassium halides show that these are completely dissociated at infinite dilutions. Preliminary investigation of the boiling points of aqueous solutions under 10 to 20 atmospheres pressure gives results indicating that potassium chloride exhibits behaviour as abnormal at the higher temperatures as at 0° or 100°. T. H. P.

2785. Adiabatics of a Mixture of Liquid and Vapour. G. Bruhat. *J. de Physique et le Radium,* 10. *pp.* 107–114, *March,* 1929.

It is known that the adiabatic curves of a fluid, as shown in Clapeyron's diagram, undergo a refraction where the curves are crossed by the saturation curve, and in former papers the author has given formulæ for the refraction of isochores at the points of intersection [see Abstract 546 (1929)]. A point M in Clapeyron's diagram is considered where the four curves meet, *viz.,* MS the curve of saturation, MA the stable adiabatic (with condensation), MA′ the adiabatic without condensation (metastable), and MI′ the isotherm of the dry vapour. When M is a point of the curve of saturation sufficiently removed from the critical point, expressions are easily found in terms of the slopes of the different curves combining the specific heat C of the dry vapour and the latent heat L of evaporation. The form of these different curves in the neighbourhood of the critical point is then discussed on classical hypotheses and on that of Verschaffelt. Analogous reasoning and corresponding formulæ are also given for the isochromes of the entropic diagram. T. B.

2786. Specific Heat of Some Condensed Gases between 10° Absolute and their Triple Points. K. Clusius. *Zeits. f. phys. Chem.* 3. *Abs. B. No.* 1. *pp.* 41–79, *April*, 1929.

This paper gives a very full and detailed description of an investigation on the specific heat at constant pressure of nitrogen, oxygen, carbon-monoxide, methane and hydrogenchloride above 10° abs. Very few observations have been hitherto made on the values of the specific heat. The principal results are those of Eucken and his co-workers [see Abstract 2428 (1928)] and Keesom and K. Onnes. Recently Giauque and Wiebe [see Abstract 1333 (1928)] have published results on solid hydrogen chloride. The object of the present paper was to check published results and to extend the values of C_p down to temperatures obtainable with solid hydrogen. Two forms of vacuum calorimeter were used, one constructed of metal and the other of glass. The advantages and disadvantages of each of these forms is fully discussed and sketches are given of the apparatus. The apparatus used for the manipulation and measurement of the gases is described with a diagram of the connections. The preparation of the pure gas in each case is detailed. The sources of error are discussed and the results of the experiments are given in tables and graphs. A full description is given of the use of the lead-thermometer, together with a calibration table for liquid hydrogen. The results of other workers are in general confirmed. The measurements of Giauque and Wiebe on hydrogen chloride show, however, a systematic deviation, which is probably due to an error in their temperature scale. The heats of melting and transition are determined. In the case of methane a transition point at 20·4° abs. is discovered. This appears not to have been noticed before. Causes for the peculiar shape of the curve between C_p and temperature in the case of methane are suggested. T. B.

2787. Molecular Motions in Rarefied Gases. E. Rutherford. *Engineering*, 127. *pp.* 319–321, *March* 15; 347–348, *March* 22; 381, *March* 29, *and pp.* 449–450, *April* 12, 1929.

Report of a course of four lectures at the Royal Institution on the kinetic theory of gases and the motions of molecules and electrons in rarefied gases, including some account of recent work. J. J. S.

2788. Entropy of Gases in Irreversible Processes. D. Enskog. *Zeits. f. Physik*, 54. 7–8. *pp.* 498–504, 1929.

This is a purely mathematical paper, and is developed as another viewpoint of an earlier paper by the author. The entropy of a gas which is not in equilibrium is calculated. The reference to the author's previous paper is Diss. Upsala, 1917. pp. 108–109. The work of J. E. Jones (*Phil. Trans. A.* 223. pp. 1–33, 1923) is also referred to. T. B.

2789. Temporal Course of Thermodynamic Processes. N. v. Raschevsky. *Zeits. f. Physik*, 54. 9–10. *pp.* 736–737, 1929.

Equations, involving entropy and free energy, determining the equilibrium of thermodynamic systems and indicating how equilibrium may be attained, are very briefly discussed. J. S. G. T.

SOUND.

2790. Experimental Exploration of the Upper Atmospheric Layers. H. Benndorf. *Phys. Zeits.* 30. *pp.* 97–115, *March* 1, 1929.

After a preliminary survey of methods already employed in investigating the physical conditions in the atmosphere, the author suggests three methods: (1) firing experiments with high angle, very long-range artillery, (2) sound waves, and (3) radio-telegraphic waves. The second is examined in detail. The theory of the propagation of sound waves in air is explained for a plane stratified medium with the air (*a*) at rest and (*b*) in motion. A synopsis is given of facts regarding the zones of audibility and silence, and their distances at different parts of the year from the source of the sound waves. The results obtained by Angenheister, Wiechert and Gutenberg indicate that the sound velocity for the inner zone depends on the temperature of the surface air layers. The larger velocities required for the outer zones can be explained only on the assumption of a considerable rise in temperature in the stratosphere reaching 306° Abs. in the layer 30 to 50 km. high. Other evidence from ozone measurements and meteorites supports the view. Finally, the author summarises the method to be employed and the best conditions for working for any future tests. [See also Abstract 1871 (1926).] R. S. R.

2791. Theory of Chemical Harmonica. Foch. *Comptes Rendus*, 188. *pp.* 697–698, *March* 4, 1929.

Discusses the conditions of maintenance of the vibrations in a column of gas partly enclosed by a cylinder placed above a flame. Satisfactory agreement between experiment and theory is obtained. W. H. Ge.

2792. Measurement of Sound Transmitting Power. H. Kietz. *Phys. Zeits.* 30. *pp.* 145–160, *March* 15, 1929.

Describes a method of measuring the sound transmitting power by use of the hot wire microphone. W. H. Ge.

2793. Intensity Gauge for "Supersonic" Radiation in Liquids. W. T. Richards. *Nat. Acad. Sci., Proc.* 15. *pp.* 310–314, *April*, 1929.

Supersonic radiation proceeding vertically through a liquid falls upon the mouth of a roughly exponential glass funnel terminating in a capillary. The rise of the liquid level in the latter is a reproducible measure of the relative sound intensity. Absolute measurements are as yet impossible, since (1) the degree of conversion of supersonic radiation into heat energy has not been studied, hence bolometric methods cannot be applied with certainty; (2) direct measurements of radiation pressure are complicated by reflection from the walls of the containing vessel. Other effects of supersonic radiation (*e.g.*, cavitation and emulsification) are too complex to form the basis for intensity measurements. L. V. C.

2794. Effects of Constrictions in Kundt's Tube. Part II. Theory. E. J. Irons. *Phil. Mag.* 7. *pp.* 873–886, *May*, 1929.

Continues the work of a previous paper [see Abstract 2251 (1929)], treating its results by the principles of "acoustical impedance" introduced by Webster. Formulæ giving the proper tones of various simple forms of resonator are derived. W. H. Ge.

ELECTRICITY AND MAGNETISM.

THEORY, ELECTROSTATICS AND ATMOSPHERIC ELECTRICITY.

2795. Triboelectricity of Quartz and Mercury. L. H. Dawson. *J.O.S.A. and R.S.I.* 18. *pp.* 344–348, *April,* 1929.

The triboelectric phenomena between an optically level surface of fused quartz and mercury were investigated at various atmospheric pressures. When precautions were taken to ensure absence of adsorbed water a reproducible charge (quartz positive) was obtained of approximately 1 esu/cm^2. Contact was made and broken as gently as possible, otherwise results were very erratic. The potential gradient was high enough (350 volts when the quartz and mercury were separated by about 1·5 mm. after contact) to ionise the intervening gas at a certain pressure (2 cm. of mercury) and so discharge the quartz. The triboelectric charge was affected by the period of contact, declining to half what it was for a short period when this was extended to 20 seconds, beyond which it appeared to remain constant. C. A. S.

2796. Kennelly-Heaviside Layer Observations during a Magnetic Storm. L. R. Hafstad and M. A. Tuve. *Terr. Mag.* 34. *pp.* 39–44, *March,* 1929.

Observations of the Kennelly-Heaviside layer by the echo-method during the magnetic disturbance of October 17, 1928, showed an unusually great effective height and a change in echo-pattern. A brief description is given of the method, and of the results obtained on undisturbed days, which are compared with those obtained during the disturbance. The marked changes observed make it clear that further records of this kind will be of great interest. AUTHORS.

DISCHARGE AND OSCILLATIONS.

2797. Types of Electric Discharge in Air at Atmospheric Pressure. M. Toepler. *Zeits. f. techn. Physik,* 10. 3. *pp.* 73–81, *and* 10. 4, *pp.* 113–118, 1929.

In order to arrive at a logical and ordered arrangement of the various types of electric discharge in air at atmospheric pressure a comprehensive review is given of the effects observed under different experimental conditions. The discussion is divided into four principal sections: (1) time effects; (2) general characteristics of luminous effects; (3) direct-current discharge types; (4) discharge types with alternating potentials and "shock" potentials. A. W.

2798. Glow Discharge in Air by an Interferometric Arrangement. J. B. Seth, C. Anand and B. Mukand. *Indian Journ. Phys.* 3. *pp.* 425–430, *March,* 1929.

A Jamin interferometer was used, the two tubes being connected so that the gas was at the same pressure in each, but one tube only was provided with platinum electrodes. A sudden shift of the bands was noticed when a glow discharge was started in the tube, this shift corresponding to a rarefaction of the gas. A simultaneous movement of the manometer indicated a rise of pressure. The inference is that some of the gas in the tube is displaced by the discharge. F. S.

2799. Control of an Arc Discharge by Means of a Grid. A. W. Hull and I. Langmuir. *Nat. Acad. Sci., Proc.* 15. *pp.* 218–225, *March*, 1929.

Attention is first directed to the difference between the problem of controlling arcs and that of controlling a pure electron discharge. Following this, an explanation is given of the fact that in an electron tube the grid ceases to influence the space charge as soon as there is appreciable gas ionisation. The explanation is based on the reasonable assumption that the grid wires are surrounded by a sheath of positive ions. The sheath thickness is very small compared with the distance between the wires and, since there is no potential gradient due to the wire outside the sheath, changing the grid potential has practically no effect on the arc current between the anode and kathode. Although it is thus not possible, in general, to stop an arc current or to modify its value by varying the grid potential, it is possible to prevent it from starting. Various methods of carrying this out are described. In one of these an alternating anode voltage is used, and if the grid voltage rises above the critical value in any cycle, the anode current starts and flows for the remainder of the positive half-cycle. If in addition to alternating anode voltage the grid voltage is also alternating, anode current only flows when the grid voltage exceeds the critical valve in the positive half-cycles. Hence the average anode current can be controlled by varying the phase of the grid voltage relative to the anode voltage. Various applications are briefly described. A. W.

2800. Mechanism of Spark Discharge. L. J. Neuman. *Nat. Acad. Sci., Proc.* 15. *pp.* 259–265, *March*, 1929.

Used a discharge tube with two nickel wire grid electrodes A and G, which can be heated electrically. G was placed a few mm. from a bright sodium kathode C, which could be kept cool by an external stream of water. The tube was filled with argon at various pressures. The sparking potential was applied between A and G (A positive), an auxiliary field about 10 % of the sparking potential was applied between G and the sodium kathode C (G positive). Positive ions passed through G and were carried on to C, but lost most of their kinetic energy on the way in impacts with neutral molecules. In some of the experiments G was coated with sodium, while in others this was driven off by heating. It appears that at low pressures the liberation of electrons from the kathode depends on the velocity of impact of the positive ions on the kathode; photoelectric action may play a minor part. As the pressure increases ionisation of the gas by impacts between positive ions and gas molecules becomes of greater importance, and the sparking potential becomes more independent of the kathode material. It is to be noted that the nickel and sodium surfaces were not out-gassed, and so electrons could be liberated by impact of positive ions. H. N. A.

2801. Ignition of Combustible Gas with Three-Part Spark. T. Terada, K. Yumoto and R. Yamamoto. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 125–126, *March*, 1929. *In English.*

Shows that as there are differences in the spectre of the parts of the three-part spark [see Abstract 2553 (1929)], so there are differences in the igniting power of the different parts of the spark. Using a gas jet at right angles to the path of the spark it is shown that near the electrodes ignition takes places very easily, but the character of the spark changes to the zigzag type, especially for the positive electrode. Taking the frequency of ignition to the cases when the spark is definitely of the three-part type, then decided minima are shown at the junctions of the positive and negative parts with the middle part; there is a maximum of approximately 80 % near the middle, but somewhat on the negative side. The value approaches 100 % near the negative electrode, but near the positive very few three-part sparks are obtained at ignition. Similar qualitative results are obtained with hydrogen, although the effect of the jet on the form of the spark is very different. R. C. F.

2802. Exponential Yield of Positive Ions in Argon. Katharine B. Blodgett. *Nat. Acad. Sci., Proc.* 15. *pp.* 230–234, *March*, 1929.

Experiments are described in which the proportions of the total current through a gas-filled discharge tube, carried respectively by electrons and by positive ions, were determined. The electron current from the hot tungsten filament was calculated from pyrometric measurements of the temperature of the filament at various points along its length, assuming the emission to be the same in argon as in a vacuum. The results are presented graphically. It is seen that the ratio of total current to electron current at higher pressures rises very rapidly with voltage. At 5 cm. pressure and 90 volts the total arc current is 13 times the saturation electron emission from the filament. This effect is shown to be in agreement with Langmuir's theory of a positive-ion sheath round the kathode, the sheath thickness being calculable from space-charge equations. A. W.

2803. Ionisation of Potassium Vapour. R. W. Ditchburn and F. L. Arnot. *Roy. Soc., Proc.* 123. *pp.* 516–536, *April* 6, 1929.

In these experiments, made as in J. J. Thomson's positive ray analysis, the ratio m/e of the ions produced is measured. The ions are produced by three methods, by photo-ionisation, electron impact and by the attachment of K^+ ions to neutral potassium atoms. The spherical apparatus is similar to that of Smyth [see Abstract 736 (1923)]. A jet of potassium vapour streams from a heated bulb upward in the sphere between two vertical electrodes of an electric field which pulls the ions out; a third electrode (up to 1000 volts) accelerates the ions which, after passing through two slits in copper discs of a soft iron tube, are deflected by a magnetic field (of 6000 gauss max.) into the electrometer. The four wire pinch carries the first electrode and two filaments (having a common connection); one of these is a Kunsman filament [an iron oxide crystal containing metallic potassium for emitting K^+ ions, see Abstract 2176 (1926)], and the other an oxide-coated platinum strip (for emitting electrons). The light from an iron arc enters the sphere through a quartz window to fall upon the vapour stream. K_2^+ ions might be formed by the attachment of K^+ ions to neutral ions and by the impact-ionisation of K_2 by K^+ ions; the former is considered more likely in view of Harnwell's experiments [see Abstract 2596 (1927)]. The photo-ionisation yields K^+ as only stable ion. The general discussion follows Franck's theory of molecules and photochemical reactions [see Abstract 1940 (1926)]. Electron impact yielded K^+ and K^- and evidence of the existence of unstable K_2^+, K_3^+ and K_3^{++}; 100-volt electrons differed from 36-volt electrons. Attachment gave definitely stable and unstable K^+ ions. Stable ions lived for at least

10^{-5} second, which is a long period compared to the molecular vibration period of 10^{-12} second; unstable ions had lives of the order 10^{-6} second. The phenomena resemble those involved in the ionisation of hydrogen and other molecules. The qualitative explanation suggested assumes that the moments of inertia of the K_2 molecule and the K^+ ion always increase on excitation. H. B.

2804. Determination of *h*. H. Feder. *Ann. d. Physik,* 1. 4. *pp.* 497–512, *Feb.* 25, 1929.

The determinations of *h* were made by means of a spectrometric method using the arrangement used by Bragg and others, with some modifications. The accuracy of the determinations depended upon the accuracy with which the wave-length was measured, which requires the accurate measurement of the angle of reflection, and upon the exact measurement of the exciting voltage. The method employed was capable of great accuracy, and the limits of error were determined. The results obtained gave the value of $h = (654 \cdot 7 \pm 0 \cdot 3) \times 10^{-29}$ erg. sec. F. J. B.

2805. Electronic Analysis: Oxides of Mg, Zn and Cd. M. Ponte. *Comptes Rendus,* 188. *pp.* 909–910, *March* 25, 1929.

The method of diffraction of electrons by crystalline powders previously described [see Abstract 2568 (1929)] has been applied with success to the oxides of Mg and Cd as well as Zn. The electrons used had velocities of 16,670 and 10,870 volts. The mean value found for *a* with CdO was 4·68 and with MgO 4·19; applying the laws of Bragg and of L. de Broglie. The author concludes from his measurements that at least for the electron velocities used the analysis is as precise as that by means of X-rays.

J. J. S.

2806. Thermionic Emission of Metallic Tubes filled with Salts. T. Peczalski and J. Cichocki. *Comptes Rendus,* 188. *pp.* 699–701, *March* 4, 1929.

A copper tube 2 mm. in internal diameter and 3 mm. in external diameter is filled with a salt and then drawn out to an external diameter of 0·9 mm. Tubes 50 cm. in length are employed. They are mounted in a vacuum of 10^{-6} mm. in the centre of a copper tube and charged by means of an accumulator. A thermionic current is produced when the tube is filled with $NiCl_2$, but not with an empty tube. Positive emission sets in more readily than negative emission. E. E. F. d'A.

2807. Electrons that are "Pulled Out" from Metals. E. H. Hall. *Nat. Acad. Sci., Proc.* 15. *pp.* 241–251, *March,* 1929.

Gives a table with estimates of the values of λ', the work in ergs required to bring an electron from the so-called non-thermal to the so-called thermian state, for different temperatures from 300° K. to 1200° K. The author endeavours to obtain a corresponding estimate of the number of the thermions compared with that of the non-thermal or valence electrons, or with that of the atoms, which will make the thermions contribute so little to the field current as the experiments of Millikan and Eyring indicate. Compares a formula of Oppenheim with another with different constants proposed by the author for calculating the emission currents from tungsten, and makes due allowance for the fact that the "field currents" in general have their origin in a few surface spots. As a result of his investigation the author considers that the thermions must in fact be very few compared with the number of atoms, 1 in 10^5 or 10^6 being mentioned. Shows that in spite of this they may have an important effect on metallic conduction, and renews his suggestion as to the influence of positive ions on conduction. H. N. A.

2808. Absorption of Beams of Electrons by Scattering. W. Bothe. *Zeits. f. Physik,* 54. 3–4. *pp.* 161–178, 1929.

It is shown that it is possible to obtain a remarkably comprehensive representation of the phenomena observed in absorption by considering only the effect of multiple scattering. The calculated distribution of the direction of the electrons agrees in ordinary cases with experiment; the coefficient of absorption in aluminium, calculated from the author's theory, agrees in a satisfactory manner with the measured value. The following table shows the relations between the calculated and observed values of a/ρ the ratio between the coefficient of absorption, a, and the density, ρ, in aluminium, silver and gold.

Element.	Velocity.	a/ρ calc.	a/ρ obs.
Al.........	0·3	2300	2900
Al.........	0·6	100	83
Al.........	0·9	7·0	6·0
Ag	0·34	4300	3070
Au	0·34	6800	2880

It will be seen that the agreement is not good for silver and is distinctly bad for gold. It is suggested that this is due to the fact that the scattering of electrons moving at a glancing angle in the metallic sheet is not correctly described in the theory. H. N A.

2809. Electronic Reflection and Diffraction. E. Rupp. *Ann. d. Physik,* 1. 6. *pp.* 801–813, *April* 6, 1929.

The Bragg reflection of electrons by single metallic crystals is observed in the metals Ni, Cu, Ag, Au, Al and Pb. Davisson and Germer's method is changed in two ways. Crystals with a definite orientation of surface are produced by evaporating the metal on to a tungsten surface and subsequent ignition. And the surface reflection of electrons is reduced by inserting a sharp edge at right angles to the crystalline surface at the point of incidence. The diffraction maxima found agree with de Broglie's relation if an index of refraction of the electronic wave is introduced.

E. E. F. d'A.

2810. Diffraction of Electrons and the Investigation of the Adsorption of Gases. L. H. Germer. *Zeits. f. Physik,* 54. 5–6. *pp.* 408–421, 1929.

Under suitable experimental conditions four different diffraction diagrams can be obtained when a beam of electrons of suitable velocity falls on a nickel monocrystal. One of these is ascribed by the author to the space lattice of the metal, a second to the outside layer of metallic atoms, a third to a thick gas layer and the last to a gas layer one atom thick. The thin gas layer has its atoms arranged in a kind of two-dimensional " gas crystal," and the distance between neighbouring atoms is twice that between the nickel atoms in the outside layer of the crystal. A diagram shows the probable relative positions of the gas atoms and the nickel atoms in the two adjoining surface layers. The observations make it probable that the surface in which the centres of the adsorbed gas atoms lie is about 3·0 Å. from that in which the centres of the outside layer of metal atoms lie. It is owing to the fact that the electrons do not penetrate into the crystal as easily as X-rays that the new method is so sensitive towards adsorbed gases. H. N. A.

2811. Diffraction of Kathode Rays by Powdered Crystals. T. Muto and T. Yamaguti. *Imp. Acad. Tokyo, Proc.* 5. *pp.* 122–124, *March*, 1929. *In English.*

Crystalline powder was precipitated (in air) on to a thin slice, about 40–50 μ thick, of the pith of a plant. Fairly good circular electron diffraction haloes were obtained using this preparation. Microscopic examination showed the powder to be deposited on the threads of the pith net and not as anticipated in the interstices. Finally, a spider's web stretched on a frame was used as the base on which to deposit the crystalline powder. This device gave electron diffraction haloes in which the effect of the web scarcely disturbed the pure effect due to the crystalline powder. Patterns for magnesium oxide and graphite were obtained and the observed intensities and deduced spacings compared with the corresponding results for X-ray diffraction. The values of the spacings obtained by the two methods agree well. There is also a fair agreement between the relative intensities. W. S. S.

2812. General Properties of Piezoelectric Quartz. Quartz Oscillator as a Frequency Standard. S. Namba and S. Matsumura. *Electrot. Laborat. Tokyo, Japan, Researches No.* 248. [45 *pp.*], *April*, 1929. *In English.*

The first part of this paper describes an investigation of various modes of vibration of quartz crystal plates when used with one or more pairs of electrodes, some of the plates being cut so that their faces contain both the optic axis and one of the electric axes, while others are cut with faces containing the optic axis but perpendicular to one of the electric axes. The results obtained with a number of crystals of different dimensions are compared with theoretical formulæ involving the dimensions, Young's modulus and the density. The second part describes observations of the stress distributions in various quartz crystal plates made by examining the luminous glow discharges obtained with the crystals mounted in sealed tubes containing neon at low pressure and by means of lycopodium powder dusted over the crystal faces. In the third part the quartz oscillator is discussed as a frequency standard. The effects on frequency of varying temperature, air gap, and the constants of the associated electrical circuit were studied in detail, the results being presented in a series of interesting diagrams. A. W.

ELECTRICAL PROPERTIES AND INSTRUMENTS.

2813. Effect of Gases on the Resistance of Granular Carbon Contacts. P. S. Olmstead. *J. Phys. Chem.* 33. *pp.* 69–80, *Jan.*, 1929.

Studies of the adsorption of gases by carbon indicate not only that gas condenses on the surface of carbon, but also that there are capillary forces sufficient to hold additional gas within. Moreover, Holm has found [see Abstract 1727 (1925)] that in the case of two granules of carbon brought close enough together to conduct electricity, the areas of contact were less than 3×10^{-5} cm. in diameter, and the current path was from carbon to carbon. In the present paper these facts and views are confirmed, and it is shown that: (1) Gas adsorbed on the surfaces of a carbon contact increases its resistance, and since conduction is from carbon to carbon, this indicates a decrease of the effective area of contact. (2) Pores exist in the material opening into the contact areas, and these have diameters smaller than 3×10^{-5} cm. When the contact area is partly outgassed the pores act as reservoirs for additional gas, which may have an effect on the resistance of the contacts. (3) A resistance may have a relation to the hydrogen content of the granules, as was found in a particular case. The experiments indicate that the resistance of a granular carbon contact is due in part to the gas adsorbed on the carbon surfaces. J. J. S.

2814. Electrical Resistance of Some Metals below the Boiling Point of Oxygen. W. Tuyn. *K. Akad. Amsterdam, Proc.* 32. 2. *pp.* 115–123, 1929. *Comm. No.* 196*b from the Phys. Lab. Leiden.*

The results are given in tables of the resistances measured in liquid O and H of the following metals: Cd, Cu, Au, In, Pb, Pt, Tl, Sn, Zn, the temperatures varying from about 90 to 1·36° K. J. J. S.

2815. Theory of the Galvanomagnetic Effect. R. Peierls. *Zeits. f. Physik,* 53. 3–4. *pp.* 255–266, 1929.

Bloch has developed a theory of metallic conductivity which improves upon Sommerfeld's theory by more exact consideration of the exchange action between electrons and lattice, and the author in this theoretical and mathematical paper shows that there may be obtained from Bloch's calculations qualitatively correct expressions for the galvanomagnetic effect, especially two indications of the Hall effect which the Sommerfeld theory does not yet afford. Similarly, from his development of Bloch's theory the author obtains an expression for the change of resistance in a magnetic field which appears to be of the correct order of magnitude. J. J. S.

2816. Variations in the Conductivity of Copper Oxide (Cu_2O). H. Kost. *Zeits. f. Physik,* 54. 5–6. *pp.* 367–371, 1929.

The conductivity of the system formed by pressing an electrode against the surface of an oxidised copper plate, the other electrode being the mother copper, is shown to alter with the polarity even when the first electrode is copper. The essential asymmetric component is the Cu_2O crystal layer in contact with the unoxidised copper. A further experiment indicates that the asymmetry varies with the thickness of the Cu_2O layer, and is to be ascribed to a specific property of the crystals rather than to effects at the boundary surface. The variation of current with temperature was also determined, for a temperature range − 20° C. to + 100° C., and for both polarities. W. S. S.

2817. Investigation of the Conductivity of Vapours of Salts. H. Querengässer. *Zeits. f. Elektrochem.* 35. *pp.* 199–206, *April,* 1929.

After summarising the work of previous investigators from Arrhenius in 1891 onwards, the author describes his experiments on vapours of salts contained in glass flasks, which show that the conductivity of these vapours cannot be established, but the observed phenomena are due to the conductivity of the glass and to the interaction of the salt vapour on the surfaces of the glass vessels. J. J. S.

2818. Measurements of Conductivity. G. Jander and O. Pfundt. *Zeits. f. Elektrochem.* 35. *pp.* 206–208, *April*, 1929.

A description of an apparatus for the measurement of conductivities of electrolytes which is a modification of the sliding-bridge method in which the telephone is replaced by a small transformer and a thermocouple with a galvanometer, and visual observations are made. Various details may be changed, and in one modification a rotating commutator is connected to the axis of a motor generator which is the source of the alternating current. J. J. S.

2819. Thermo-E.M.F. in a Copper Wire Subjected to Asymmetric Heating and Longitudinal Tension. J. B. Seth, C. Anand and M. R. Anand. *Indian Journ. Phys.* 3. *pp.* 431–436, *March*, 1929.

The Benedic and similar effects were examined by subjecting a copper wire to asymmetric heating whilst one portion of it was also exposed to strain by being stretched within and beyond the elastic limit up to the breaking point. As the extension was increased the e.m.f. produced rose to a maximum, and then to a second maximum before attaining a constant value. The authors consider that the e.m.f.'s generated are intimately connected with the breaking up of the aggregates of the crystals in the material which produces permanent set, and that the asymmetric heating is necessary to bring about the changes in the motion of the electrons to which the thermo-e.m.f.'s are due. J. J. S.

2820. Dielectric Behaviour of Glass in A.C. Circuits. Part II. Effect of Frequency and Temperature upon the Power Loss. Louise S. McDowell and Hilda L. Begeman. *Phys. Rev.* 33. *pp.* 55–65, *Jan.*, 1929.

The variation with frequency and temperature of the power loss and power factor of glass were investigated. Six glasses kept at several constant temperatures were examined and the power factor, power loss per unit applied p.d., and capacitance were measured with frequencies varying from 800 to 4000 cycles per sec. Two other glasses were also tested at different frequencies and temperatures. For the audio frequency range the results obtained by the authors accord with the equations of v. Schweidler rather than with those of Wagner and Joffé. It is suggested that the rapid increase in power factor at frequencies above 700 kilocycles may indicate another cause of power loss effective only at higher frequencies. J. J. S.

2821. Resistance of Insulating Materials. Effect of Voltage and Frequency. P. Böning. *Zeits. f. techn. Physik*, 10. 3. *pp.* 82–93, *and* 10. 4. *pp.* 118–124, 1929.

The behaviour of insulating and other materials is first discussed theoretically from the basis of ionic adsorption at internal boundaries, application being particularly made to the dependence of the resistance on the applied voltage. In the case of direct current potentials the expressions showing this dependence are comparatively simple, but for alternating potentials this is by no means the case. By means of simplifying assumptions, expressions are, however, derived showing the dependence of the loss angle on the applied potential and frequency. The formulæ indicate that the effective resistance of an insulating material should be smaller for alternating than for d.c. potentials; also that the loss angle should have a maximum value for some particular frequency.

The paper concludes with an account of experiments verifying the existence of space charges in insulating materials. A. W.

2822. Constant Voltage High-Tension Generators. G. E. Bell. *Brit. J. of Radiology*, 2. *pp.* 156–173; *Disc.*, 173–174, *April*, 1929.

Gives a general review of methods of obtaining direct high-tension energy and concludes with the description of an apparatus used at the National Physical Laboratory which consists of a four-valve Gratz connection with a condenser and choke filter. A regulating device for this apparatus is also described. The output is 30 mA at 100 kV. B. J. L.

2823. Increase of Sensitivity of Electrical Measuring Apparatus. Quevron. *Comptes Rendus*, 188. *pp.* 1039–1040, *April* 15, 1929.

The author employs an electromagnet having sufficient ampere-turns to produce saturation of the magnetic field instead of a permanent magnet, thus eliminating the parasitic effects in the field. It is possible to detect 10^{-8} ampere or 10^{-5} volt. Examples are given of its use as (1) a millivoltmeter for measuring the temperature of thermo-junctions, and (2) a micro-ammeter for currents from photoelectric cells. R. S. R.

2824. Use of Amplifying Valves for Measuring Small Amounts of Energy. J. Brentano. *Zeits. f. Physik*, 54. 7–8. *pp.* 571–581, 1929.

Points out that, in a certain group of physical measurements, the energy passing between the measuring apparatus and the apparatus in which the phenomenon studied is taking place deserves special attention. Under ordinary conditions the use of amplifying valves may introduce disturbances which detract from the value of the measurements. The author has investigated a bridge connection for two amplifying valves, for the measurement of weak continuous currents and small potential differences, and finds that by this means it is possible to arrive at freedom from disturbances due to external actions. H. N. A.

2825. Summary of Applications of Constant-Frequency Oscillating Valves. F. Maske. *Phys. Zeits.* 30. *pp.* 197–201, *April* 1, 1929.

A summary of the various applications of oscillating valves to the measurement of physical quantities. The methods used are correlated, and details of the apparatus are given in the more important cases. G. E. B.

2826. Ultramicrometer of Dowling. S. Ekelöf. *J.O.S.A. & R.S.I.* 18. *pp.* 337–341, *April*, 1929.

Improvements in Dowling's ultramicrometer, more especially that form of it described by Obata [see Abstract 1098B (1928)] using the capacity-change method, are described: (1) by inserting an appropriate grid battery a sensitivity of 1 m.a. per $1\mu\mu$ F. capacity-variation was attained (Tube: Telefunken R.S. 228); (2) by replacing the grid battery by an appropriate grid-leak condenser combination the sensitivity was further increased to 4 m.a. per $1\mu\mu$ F. capacity-variation. Full details are given, and the precautions necessary to measure a displacement of 10^{-6} mm. Application of the method to the measurement of the vibrations in a steel rack used to prevent ice reaching the water-wheels of a hydroelectric installation in Sweden, situated 6 m. under water, is described. C. A. S.

ALTERNATING CURRENTS AND MAGNETISM.

2827. Functional Operations of Mathematical Physics. Angelina Cabras. *Accad. Lincei, Atti*, 9. *pp.* 312–318, *Feb.* 17, 1929.

Referring to recent researches of Sbrana, L. Straneo and J. J. Smith upon groups of operators of the type Δ^s, $\left(\frac{a+b\Delta}{c+d\Delta}\right)^s$, etc., where Δ is the symbol of the derivation with respect to time, *i.e.*, $\Delta = \frac{d}{dt}$, while s is any real number; and the discussions upon these at the International Congress of Mathematics at Bologna last year, where the author brought forward a paper on a complex form of Wheatstone's bridge, operators of the type $\frac{P(\Delta)}{Q(\Delta)}$ are considered in the present paper, P and Q being any two polynomes whatever with coefficients not functions of the principal variable t. The valuation of these operators is discussed, starting with the fundamental theory given by Giorgi. The physical valuation of these is of importance in the study of variable currents occurring in networks.

J. J. S.

2828. Curie's Laws. R. Brunetti. *N. Cimento*, 6. *pp.* 85–98, *March*, 1929.

Theoretically deduced, and experimentally verified, that Curie's paramagnetic constant in quantistic form is characteristic of the energy-level in which the atom finds itself; for example, if an atom possessing a multiple fundamental level be excited thermically, the product of the magnetic susceptivity and the absolute temperature instead of remaining constant becomes the mean of the Curie constants relative to the normal level of the atom and the excited levels. The distance between the sub-levels ^2F of triatomic cerium is found to be less than that calculated from the Sommerfeld data; reasons are given for anticipating this result.

A. D.

2829. Local Dissipations of Energy in the Magnetic Field. L. and P. Lombardi. *Elettrotecnica*, 16. *pp.* 142–146, *Feb.* 25, 1929.

Referring to the papers of W. Rogowski on the measurement of magnetic tension considered as integral of a line of magnetic force, the authors, noting the excessively laborious nature of Rogowski's method in practice, describe a simpler arrangement with the use of a wattmeter. This consists of a reflection electrodynamometer whose two circuits, fixed and movable, are respectively connected to the spiral of the tension measurer, which has the extremities brought near to the boundaries of the magnetic member where the loss is to be determined and to a secondary spiral which is wrapped round the member referred to, and can serve for the measurement of the continuous flux of induction. The theory, which is simple, is discussed, and details of the experimental measurements given.

J. J. S.

2830. Rôle of the Conduction Electrons in Ferromagnetism. Part I. J. Dorfman and R. Jaanus. Part II. J. Dorfman and I. Kikoin. *Zeits. f. Physik*, 54. 3–4. *pp.* 277–296, 1929.

The investigation is directed to the question whether, in a ferromagnetic metal, the conduction electrons or the electrons bound to the positive ions of the metal, play the rôle of elementary magnets. The jump in the specific heat at the Curie point may be written $\Delta_\theta c_a$ per atom, and this will be made up of $\Delta_\theta c_i$ due to the positive ions and $\Delta_\theta c_e$ due to the conduction electrons; $\Delta_\theta c_a = \Delta_\theta c_i + n\Delta_\theta c_e$, where n is the number of conduction electrons per atom. If only the conduction electrons are involved in the ferromagnetism of the metal, $\Delta_{\theta}c_i = 0$, if only the positive ions, $\Delta_{\theta}c_e = 0$. $\Delta_{\theta}c_a$ is measurable directly calorimetrically; $\Delta_{\theta}c_e$ is obtainable from the sharp change in the thermoelectric magnitude $T\frac{d^2E}{dT^2}$, at the Curie point. Measurements of $T\frac{d^2E}{dT^2}$ in the neighbourhood of the Curie point (*c.* 630° Abs.) are given for nickel, and the value $4 \cdot 8 \,.\, 10^{-24}$ cal./deg. deduced for $\Delta_{\theta}c_e$, against $3 \cdot 65 \,.\, 10^{-24}$ cal./deg. (Ch. Lapp) and $3 \cdot 87 \,.\, 10^{-24}$ cal./deg. (Weiss and Forrer) for $\Delta_{\theta}c_a$. The fact that $_{\theta}c_a$ and $\Delta_{\theta}c_e$ are of the same order of magnitude means that the conduction electrons are alone concerned in ferromagnetism. Further, since these do not move in closed orbits, the magnetic moment they give rise to must be due to their intrinsic spin. It is shown that $\Delta_{\theta}c_e = 4 \cdot 8 \,.\, 10^{-24}$ cal./deg. leads to a value of the spin moment of the conduction electron equal to one Bohr magneton. The number of conduction electrons in nickel at the Curie point is shown to equal only about 78 % of the number of atoms; at the absolute zero it is estimated that the number is reduced to 60 %. W. S. S.

2831. Atomic Theory of Ferromagnetism. N. Akulov. *Zeits. f. Physik*, **54**. 7–8. *pp.* 582–587, 1929.

Gives the general relation between the alteration of the internal energy density of an iron monocrystal and the area of the surface between the magnetisation (B–H) curves for field directions differently inclined to the principle axis. The general formula for calculating these surfaces is derived, and the relation between them and the magnetostriction. Quantitative agreement is found in all cases between theory and the results of measurements. The measurements show that there are no hysteresis losses in iron monocrystals. In addition to the action of magnetic dipoles an action, in nature similar to that of quadripoles, which may not be purely magnetic in character, and which is smaller than that of the dipoles, must play an important part in ferromagnetism. If an iron atom had an electrical dipole moment of the order of magnitude 10^{-18}, and its direction could be affected by an external magnetic field, the magnetostriction would be 2000 times as great as that observed. H. N. A.

2832. Diamagnetism of Gases. A. Glaser. *Ann. d. Physik*, **1**. 6. *pp.* 814–820, *April* 6, 1929.

Gives additional reasons for regarding the anomaly in the proportionality of the diamagnetic effect to pressure in noble and inert gases as real. As the pressure decreases, the effect increases to as much as three times the normal value. The effect is not shown in oxygen. E. E. F. d'A.

2833. Magnetisation of Single Crystals of Cobalt. S. Kaya. *Tohoku Univ., Sci. Reports*, **17**. *pp.* 1157–1177, *Dec.*, 1928. *In English. Report No.* 206 *from the Research Inst. for Iron, Steel and Other Metals.*

Large crystals of cobalt, several cubic centimetres in volume, were prepared by slowly cooling the single crystals obtained during the solidification of the metal through its transformation point 470°. From these crystals, two circular discs about 4·5 mm. in diameter, with their planes coinciding respectively with the two principal planes (0001) and $(10\bar{1}0)$, were made. The magnetic properties of these planes were studied by the same method as that used in the case of iron and nickel crystals. In the plane $(10\bar{1}0)$ there are two particular directions, [0001] and $[10\bar{1}0]$, perpendicular to each other; one is the direction of easy magnetisation and the other that of difficult magnetisation. The parallel and perpendicular components of magnetisation in this plane vary with a period of 180°. In the (0001) plane, two principal axes, [10$\bar{1}$0] and [11$\bar{2}$0], intersecting each other at an angle of 30°, are both directions of difficult magnetisation. The saturation value of the intensity of magnetisation was found to be 1422 at 26°. Lastly, the results of the present experiment were explained on the theory of magnetisation of ferromagnetic crystals put forward by K. Honda and J. Ôkubo [see Abstract 1287 (1916)]. AUTHOR.

2834. Magnetic Sounding of Shafts. J. Peltier. *Comptes Rendus*, 188. *pp*. 701–703, *March* 4, 1929.

Specimens 45 cm. in length and 2 cm. in diameter are suitably centred and exposed to the influence of a magnetic field with the magnetising current passing through a resistance of 2000 ohms and a galvanometer sensitive to 10^{-7} ampere. An artificial bubble 2 mm. in diameter and 7 mm. below the surface was faultlessly indicated by a deflection of the galvanometer. It is possible to substitute a loud speaker for the galvanometer. E. E. F. d'A.

2835. Measurement of Magnetic Susceptibility. J. Koenigsberger. *Zeits. f. Physik*, 54. 7–8. *pp*. 511–517, 1929.

Describes a simple method of measuring the magnetic susceptibility in weak fields which is dependent on the action of a magnet on a substance with plane boundary surfaces, the susceptibility (K) of which differs from that of the material surrounding the magnet (K_0). The measure of the action is obtained either from the twist imparted to the magnet or from the force required to compensate this turning effect. The action produced between the magnet and the material under test is proportional to $K-K_0$, and, provided a calibration of the system is obtained, such as by using an iron chloride solution, the absolute value of K can be obtained for weak fields of less than 10 gauss. Definite correction factors must be used when the material has finite different dimensions. R. C. F.

2836. Measurement of a Magnetic Field. D. R. Inglis. *J.O.S.A. and R.S.I.* 18. *pp*. 354–356, *April*, 1929.

Describes a simple null method for the measurement of the strength of a magnetic field which does not require special commutators. The principle is essentially the comparison of the field of an unknown coil with that of a standard coil. The coils, which are arranged so that their fields are in opposition, are connected in parallel across the supply through a single pole switch so that both fields are made simultaneously. There is a fixed resistance in the standard coil circuit, and a continuously variable one in the unknown coil circuit, so that balance can be obtained; the strength of the unknown field being then equal to the strength of the standard field at the place in use multiplied by the ratio of current in the standard circuit to that in the coil under test. Balance is shown by a galvanometer connected to a small search coil slipped inside the standard coil, and the resistance in the standard coil circuit is such that the time of growth of the current does not produce a galvanometer deflection.

R. C. F.

2837. Diamagnetic Field of the Outer Atmosphere. S. Chapman. *Terr. Mag.* 34. *pp*. 1–16, *March*, 1929.

The magnetic field of the diamagnetic layer in the outer atmosphere, to which R. Gunn [see Abstract 2844 (1928)] has recently drawn attention, is examined and shown to be remarkably similar to that of the daily magnetic variations. AUTHOR.

2838. Diamagnetic Theory of Undisturbed Terrestrial-Magnetic Variations. R. Gunn. *Terr. Mag.* 34. *pp.* 17–21, *March,* 1929.

In an earlier paper [see Abstract 2844 (1928)] the author outlined a theory of the terrestrial-magnetic variations based on diamagnetism existing in the upper atmosphere; which was shown to follow from simple considerations of the motion of ions or electrons which spiralled about the earth's magnetic field as a result of their thermal agitation. It is the purpose of this paper to extend the original ideas and supply evidence in support of the theory that was not available in the original paper. H. H. Ho.

2839. Preliminary Results of Ocean Magnetic Observations on the "Carnegie" from Balboa to Easter Island and Callao, October, 1928, to January, 1929. J. P. Ault. *Terr. Mag.* 34. *pp.* 23–34, *March,* 1929.

Preliminary information regarding magnetic declination, inclination and horizontal intensity are tabulated, and mention is made of sites where sonic depths, ocean and tow-net 24-hour atmospheric-electric runs, evaporation measurements, pilot-balloon flights, complete photographic potential-gradient records, bottom samples and biological collections were made. By comparison with magnetic values found by the Carnegie, 1909–1928, the average annual change values for the North Atlantic have been obtained and tabulated [see Abstract 1854 (1928)]. R. S. R.

2840. Distribution Coefficients for Vertical-Intensity Magnetic Variometers. H. E. McComb. *Terr. Mag.* 34. *pp.* 59–61, *March,* 1929.

Scale-values were determined in the usual manner by means of a small deflector at short distances and with the deflection-bar set for various azimuths. These were referred to the values obtained with a large deflector at a great distance as standard, and from the resulting differences the distribution-factors were computed. AUTHOR.

2841. Variometer Scale-Value Determinations with a Large Deflector. A. K. Ludy. *Terr. Mag.* 34. *pp.* 63–66, *March,* 1929.

Vertical and horizontal-intensity variometer scale-values were determined by the usual method of using a small deflector at short distances and a large deflector at great distances. The results indicate that the latter method has several advantages and is to be preferred. AUTHOR.

2842. Magnetic Intensity by the Method of Oscillations. W. N. McFarland. *Terr. Mag.* 34. *pp.* 67–72, *March,* 1929.

The aim of this paper is to develop the best arrangement of the oscillation-observations of the measurement of horizontal intensity by consideration of the relative precisions obtained by varying the length of the series and the method of computation. The variation of precision in the final mean value with arrangement of the observational and computational work is shown by a figure, and the formula is stated for the propagation of this observational error into the computed value of the horizontal intensity. AUTHOR.

2843. Sources of Error in Determinations of Magnetic Declination. G. S. Ljungdahl. *Terr. Mag.* 34. *pp.* 73–76, *March,* 1929.

In a magnetometer, fitted with an optical collimating-system attached to the magnet, a possibility exists of corrections, which are due to defects in the lens. A perfect magnetometer ought not to have any corrections at all in determining D. A criterion of non-correction is given. Errors of observation may be diminished by pointing on more than one reticle in the field of view of the telescope. AUTHOR.

RADIOGRAPHY AND ELECTROPHYSIOLOGY.

2844. Precise Measurement of X-Ray Dosage. L. S. Taylor. *Bureau of Standards, J. of Research,* 2. *pp.* 771–785, *April,* 1929.

A comparison of the standards of X-ray dosage was made by Behnken and showed a variation of 4 % between various laboratories. No explanation for these differences has been given, and it has been assumed that they are traceable to experimental error. The present paper describes the results of some preliminary measurements made at the Bureau of Standards, and it appears that improper electrostatic field conditions within the ionisation chamber could account for at least some of the variation. A description is given of the X-ray generating equipment followed by a detailed account of the ionisation measuring system, essentially a modified Duane type of chamber. Experiments have been made using a discharging fibre electrometer, a charging fibre electrometer, an idiostatic fibre electrometer, and a null reading fibre electrometer. The results obtained by these different methods are not in agreement, field distortion accounting for the differences. An analysis of the methods is made and certain other possible errors in the measuring system discussed. It is claimed that apart from the diaphragm error the accuracy in the determination of *r*/min. is 1·0 % or better. W. V. M.

2845. Ionisation Method of X-Ray Measurement. J. A. Crowther. *Brit. J. of Radiology,* 2. *pp.* 175–184; *Disc.,* 185–187, *April,* 1929.

A discussion of the fundamental principles underlying the use of an ionisation chamber in the measurement of X-ray energy. The relationship between the measurement of real total energy of an X-ray beam by absorption and measurement of the rise of temperature in a given mass of material on the one hand, and the results of ionisation measurements in air on the other is the chief theme of the paper. Certain discrepancies in the results of measurements of the energy required to produce a pair of ions in air are believed by the author to be concerned rather with the ionisation measurements than the heat measurements in spite of the difficulties of the latter. The international unit of X-ray dose (rontgen-*r*) is defined and the corresponding energy absorbed shown to be 0·134 ergs. The problem of quality measurement is discussed, and in particular the method of expressing the quality by means of a half value layer or the effective wave-length by absorption in a standard material, for instance copper or aluminium. The latter method is regarded as definitely misleading, since the ionisation produced in a given chamber is a measure of the energy absorbed in the air, and in a heterogeneous beam of rays the softer components are very much overemphasised. On filtering, the spectral distribution of the energy is altered, and whereas, for instance, the interposition of, say, 5 mm. of aluminium between an ionisation chamber and source may reduce the indications of an ionisation chamber to one-half, experiments with a calorimeter show that the energy of the beam has only been reduced by roughly 25 %. Further experiments supporting these views are given. The difficulty of obtaining the whole of the ionisation produced by an X-ray beam in a "standard" ionisation chamber of the parallel electrode type is mentioned, since the chambers would appear to have to be made of considerable size. An ionisation chamber consisting of three parallel electrodes of paper graphited is described and some of its properties mentioned. It is suggested that the next step in the setting up of an X-ray unit of dosage is to define a standard ionisation chamber to be used for the calibration of all other chambers. W. V. M.

2846. Investigation of an Ionisation Chamber for X-Ray Measurements. L. R. G. Treloar. *Brit. J. of Radiology,* 2. *pp.* 188–195, *April,* 1929.

The paper contains an account of some measurements of the ionisation produced in a chamber of cylindrical form by a beam of homogeneous X-radiation directed axially through it, having electrodes placed perpendicularly to the axis. The experimental chamber was compared with a chamber of standard form employing parallel plate electrodes. The theoretical consideration of such a chamber was given by Bragg ("Studies in Radioactivity"). Experimental details of the chambers are given. The ionisation produced in the experimental chamber for homogeneous radiations of wave-lengths 0·71 Å. and 1·54 Å. is compared to that in the standard, and it is found that each electrode surface contributes an additional ionisation equal to that which would be produced by the radiation in passing through 0·35 mm. of air. This value showed no variation with wave-length or distance of separation of the electrodes over the ranges employed. Experiment shows that if the electrodes are of metal the ionisation due to these electrodes increases with atomic number as theoretical considerations suggest. W. V. M.

2847. Comparison of the Electrostatic and the Electromagnetic Methods of X-Ray Measurement. E. A. Owen and H. I. Jones. *Brit. J. of Radiology,* 2. *pp.* 196–208; *Disc.,* 208, *April,* 1929.

The international unit of X-ray dose is defined, and it is pointed out that it is of importance that a variety of methods be employed to establish the standard embodying the unit in a practical form. As a first step in the work on the unit the authors have measured electrostatically and electromagnetically the ionisation current produced by a beam of X-rays in an ionisation chamber containing parallel plate electrodes and having open ends. The electrostatic measurements are described in some detail, the capacity of the system being measured by comparison with a standard Kelvin air condenser itself checked against a standard inductance by Anderson's method. The value of air ionised was determined photographically. Detail is given of experiments using the electromagnetic method, using a similar arrangement to that of Duane. The results of measurements of the ionisation current by the two methods agree to approximately 1 %. The paper concludes with some observations on the relative merits, difficulties and advantages of the two methods. W. V. M.

CHEMICAL PHYSICS AND ELECTROCHEMISTRY.

2848. Influence of Gases in Activated Carbon on the Adsorption of Electrolytes. Part I. B. Bruns and A. Frumkin. Part II. R. Burstein and A. Frumkin. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 141–166, *April*, 1929.

Part I. Sugar carbon, activated by heating to 1100° C. in carbon dioxide for 5 hours, behaves in aqueous solutions as a gas electrode; the adsorption of strong electrolytes by the carbon results from the formation of an electrical double layer at the carbon-solution interface, the sign of the charge on the carbon surface being determined by the nature of the gas present in the carbon. In the presence of air, activated carbon passes OH-ions into the solution, becoming positively charged itself; the formation of the double layer in this case is accompanied by an adsorption of acid. The quantity of acid adsorbed is markedly increased by the addition of traces of platinum to the carbon, indicating an increase of oxygen potential. Carbon containing a certain amount of platinum sends H-ions into the solution in the presence of hydrogen, thereby becoming kathodic. In this case an adsorption of alkali occurs, the acidic adsorption falling to zero. In the absence of platinum, however, the oxygen is only partially removed by hydrogen; the adsorption of acid on carbon free from platinum is smaller in hydrogen than air, but does not become zero. In hydrogen alkali is not adsorbed by platinum-free carbon. *Part II.* When activated carbon is heated in hydrogen to 1000° C. and introduced into an air-free solution out of contact with air the adsorption effect is the converse of that observed in air: no adsorption of acid occurs, but alkali is adsorbed, a neutral solution becoming acidic in contact with the carbon. On exposing this carbon to air it recovers its original oxygen and again adsorbs acids. Carbon which has adsorbed sulphur dioxide is purified by heating in a stream of hydrogen, when its adsorptive power for acids is increased. When sulphur dioxide is excluded during activation of the carbon no increase in adsorption of acid is produced by heating the carbon in hydrogen. Carbon carrying adsorbed hydrochloric acid gives it off more readily on heating in hydrogen than in nitrogen. A. J. M.

2849. Behaviour of Gas-Free Activated Carbon towards Electrolytes. R. Burstein and A. Frumkin. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 219–220, *April*, 1929.

Sugar carbon free from ash is heated *in vacuo* (10^{-5} mm. Hg) to 1000° C. and then brought into contact with a boiled solution of sodium chloride, also *in vacuo*. Under these conditions no hydrolytic adsorption occurs. On coming into contact with air the carbon becomes positively charged and begins to adsorb hydrochloric acid, but there is no adsorption of sodium hydrate. The results confirm the theory of Frumkin [see preceding Abstract]. A. J. M.

2850. Dependence of the Adsorption of a Dissolved Substance upon the Properties of the Solution and the Solvent. W. Herz and L. Lorenz. *Kolloid Zeits.* 47. *pp.* 331–334, *April*, 1929.

The adsorption of iodine from solutions in benzene and carbon tetrachloride, and from solutions in heptane and dipropyl ether by carbon, was studied. The densities and internal friction of the various mixtures of solvents were determined, and the results showed that a constant relationship exists between the adsorption of a substance from organic solvents and mixtures of these solvents and the solubility of the material, as well as the densities and internal friction of the saturated solutions and the solvents. F. J. B.

2851. Solubility in the Gaseous Phase, especially in the System: $NH_3(l) - NH_3(g)$, $H_2(g)$, $N_2(g)$. H. L. Cupples. *Am. Chem. Soc., J.* 51. *pp.* 1026–1033, *April*, 1929.

A concept of solubility is presented in this paper which seems to be especially applicable to systems involving one or more gaseous components, *viz.*, a change in the activity of one component due to the presence of others. A method is outlined by which the two-phase system $NH_3(l) - NH_3(g)$, $H_2(g)$, $N_2(g)$ has been examined for the presence of such a solubility effect. It is concluded that, within the fairly large error of calculation, there is no indication of a solubility effect of the gas phase for ammonia vapour. H. H. Ho.

2852. Colloidal Behaviour of the Sulphides and Hydroxides of Cadmium and Zinc. W. Daus and O. F. Tower. *J. Phys. Chem.* 33. *pp.* 605–612, *April*, 1929.

The best conditions are ascertained for obtaining these sulphides in the form of Liesegang's rings. The gelatinous media used were silica, agar-agar and gelatine. It is found that the sulphide ion must be in the gel and the metallic ion above the gel. The results are accounted for by Bradford's theory assuming that the sulphide ions are more strongly adsorbed by the precipitated sulphides than are the metallic ions. Data is given for the preparation of colloidal solutions of cadmium and zinc hydroxides, and gels of cadmium and zinc hydroxides have been prepared in solutions containing glycerine. J. K.

2853. Solidification of Gelatine Sols. A. Lottermoser and W. Matthaes. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 129–136, *April*, 1929.

The heat changes which took place when gelatine sols with different water contents were allowed to solidify were measured. Sols containing 10 %, 20 %, 30 % and 60 % of gelatine were prepared and the time-cooling curves were observed. It was found that during solidification a transition change took place, and a discontinuity in the time-cooling curve was observed. It was concluded that a similar behaviour was characteristic of all temperature reversible colloids. F. J. B.

2854. Structure of Solutions of Gelatine. Marinesco. *Comptes Rendus*, 188. *pp.* 1163–1165, *April* 29, 1929.

Reference is made to an earlier investigation [see Abstract 622 (1929)] wherein it was shown that a study of the dialectric constants of a colloid gave useful data for determining cell structure and particularly the various combinations of the colloid with the dispersion medium. From the variations in specific inductive power with the concentration it is possible to deduce the amount of "water dialectrically saturated" adsorbed per gramme of colloidal solid. In the present paper the results obtained by measuring the dialectric constant of commercial gelatine at 20° for a wave-length of 6·5 metres are given. It is shown that for concentrations up to 0·75 per 100 the inductive power increases linearly with the concentration, and after passing the dialectric constant value of 108 rapidly diminishes. This is interpreted to mean that the gelatine molecule has a very large electric movement, much greater than that of water, which is itself highly polarised. The dialectric constant curve at 20° is diagrammatically compared with the gelification curve. J. K.

2855. Silver Sols Coloured with the Aid of Hydrogen Peroxide. E. Wiegel. *Kolloid Zeits.* 47. *pp.* 323–325, *April*, 1929.

There are two kinds of coloured silver sols. The primary sols are formed by varying numbers of nascent silver particles attaching themselves to germs, the secondary by the flocculation of very small primary particles. The primary particles are more compact than the secondary and of metallic lustre, and differ in their reflected light from the secondary. The author prepares the primary particles without the addition of gelatin as protective colloid by adding a small quantity of dextrin to the silver nitrate (Cary Lea's colloid) and precipitating with H_2O_2. As more of the latter is added, the colour of the particles changes in translucent light from orange-yellow through violet and blue to colourless, and in reflected light from grey-blue to olive-green and reddish-yellow; the ultramicroscopic particles also change their colours. The colloids thus prepared are less complex (owing to the absence of gelatin) and the colours are more beautiful. H. B.

2856. Devitrification of Glass. P. Villard. *Comptes Rendus*, 188. *pp.* 969–972, *April* 8, 1929.

A tube of glass which is readily devitrified in a blowpipe flame undergoes no change on the inner surface when each of the gases in the flame is passed separately through the tube heated to the glass-blowing temperature, 750°–950° C., nor does devitrification occur if the glass is heated out of contact with air. The passage of hydrogen containing about 1 % oxygen, however, causes immediate devitrification at that temperature. The glass becomes clear again if any one of the gases composing the flame is passed over the surface. The devitrification by hydrogen containing oxygen is accompanied by the yellow glow of the sodium flame, and further experiments show that the devitrification is caused by a reduction of combined sodium to the free state and its removal. A similar process occurs in potash glasses. The phenomenon is distinct from that observed by Réaumur, which is due to liquation of the constituents of the glass at temperatures lower than 750° C. Devitrification during the working of glass may be avoided by heating in a flame in which combustion is as complete as possible. A. J. M.

2857. Rise of Yield Point in Metals on Straining and Ageing. Galibourg. *Comptes Rendus*, 188. *pp.* 993–995, *April* 8, 1929.

Specimens from a normalised soft steel were overstrained and aged for various periods up to 8 days at temperatures of 13·5° C., 50° C. and 180° C., after which the yield point was redetermined. In the normalised condition the yield point was 25 kg. mm^2, and the ultimate stress 38·5 kg. mm^2. The specimens were strained under a stress of 33 kg. mm^2. Ageing at 13·5° C. raised the yield point to 38·4 kg. mm^2. in 8 days. At 50° C. the yield point rose to 39 k.g mm^2. in 7 hours, while at 180° C. a maximum value of 39 kg. mm^2. was attained in 3 minutes 20 seconds. The rise in yield point is a hyperbolic function of the duration of ageing. A similar ageing effect has been observed in strained nickel at 180° C. A. J. M.

2858. Nickel-Copper Alloys. A. Krupkowski. *Rev. de Mét.* 26. *pp.* 131–153, *March, and pp.* 193–208, *April*, 1929. *Engineer*, 148. (*Metallurgist*). *pp.* 108–109, *July*, 1929.

A very thorough examination of the nickel-copper alloys has been carried out. The results are given in numerous tables and curves, previous investigations are summarised and differences in results discussed. A series of 11 such alloys was prepared, containing from 2·1 to 86·6 % of nickel (percentages by weight). Samples were rolled and annealed for 75 hrs. at 750–850°. The properties examined were: (1) Magnetic permeability (from − 183° to 400°). The curve connecting the Curie point with composition is a straight line from 368·3° for pure nickel to − 141° for 55 % nickel, indicating 0° for 66 % nickel and, by extrapolation, 41·5 % for absolute zero. No trace of hysteresis was found. (2) Electrical resistance and its temperature coefficient (− 258° to 100°); (3) thermo-electric force, relative to copper (− 78° to 100°); (4) dilatation (− 252·6° to 444°); (5) e.m.f. of solution; (6) hardness by le Grix's method. (2), (3) and (4) all showed distinct variations at the Curie point. (2) also showed variations at the point of transformation of Cu_α to Cu_β. The temperature coefficient of resistance practically vanished for the alloy containing 41·5 % nickel (constantan). Micrographic examination showed no change in structure corresponding to the Curie point, or the supposed change from copper to nickel as the solvent component. X-ray examination showed the same structure (face-centred cubic) for all alloys irrespective of composition, thus indicating that magnetic properties are not connected with the arrangement of the atoms relative to one another.

C. A. S.

2859. Velocity of Solution of Tin and Certain Tin-Copper Alloys in Acids. M. Centnerszwer. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 167–179, *April*, 1929.

Tin dissolves with measurable velocity in hydrochloric acid only when the concentration of the acids exceeds 6-normal. In this case the process of solution may then be regarded as of the fourth order, which is in agreement with the fact that diffusion exerts only a subordinate influence on the velocity of solution, and that the temperature quotient of the reaction constant possesses a value characteristic of chemical processes. Addition of copper increases the velocity of solution of the metal, a maximum value being reached with about 1 % of copper. In the action of hydrochloric acid only the tin dissolves, the copper (or a tin-copper compound) remaining undissolved. Owing to the lowering of the overvoltage this gives rise to the appearance of local elements. The solution thus becomes an electrochemical process, the velocity of which is increased by stirring.

T. H. P.

2860. Action of Electrical Discharges on Gases containing Hydrocarbons at Diminished Pressure. F. Fischer and K. Peters. *Zeits. f. phys. Chem.* 141. *Abt. A. pp.* 180–194, *April*, 1929.

An arrangement is described suitable for carrying out gas reactions under the influence of electric discharges at diminished pressures. Methane and other hydrocarbons are converted almost quantitatively into acetylene under these conditions. Mixtures of nitrogen and hydrocarbons give rise to hydrocyanic acid in the glow discharge. Increase in the rate of flow of the gaseous mixtures is accompanied by improved utilisation of the energy.

T. H. P.

2861. Topochemistry of Mercury Catalysis of Hydrogen Peroxide, and the *p*H Value for Pulsation. G. Bredig and A. Stark. *Zeits f. phys. Chem.* 2. *Abt. B. pp.* 282–286, *March,* 1929.

It was shown the decomposition of hydrogen peroxide on a mercury surface formed a striking instance of phase-line limit catalysis. The pulsating, catalytic decomposition of hydrogen peroxide was investigated, and it was found that the *p*H value for pulsation to take place was very sharply limited, and the limit was found to lie between *p*H = 6·65 and *p*H = 7·05. F. J. B.

2862. Temperature Coefficients of Some Photochemical Reactions. G. B. Kistiakowsky. *Nat. Acad. Sci., Proc.* 15. *pp.* 194–197, *March,* 1929.

A theory of gaseous explosions, first suggested by Christiansen and Kramers and recently developed by Semenoff [see Abstract 2226 (1928)], assumes that in many cases the formation and propagation of an explosion-like reaction in gases may be due to the thermal reaction chains becoming infinitely long. The non-sensitised photochemical water formation would appear to have only very short chains even at the explosion temperature, whereas, according to Semenoff, the thermal chains become infinite at this temperature; and since such divergence is unsatisfactory the present experimental investigation of this reaction has been made, and also of the rate of carbon dioxide formation from dry oxygen and carbon monoxide. All the experiments, which are fully described, were carried out with stoichiometric mixtures of the gases, and the results are far from following the Arrhenius equation, $d \ln k / dT = \phi / RT^2$, but, instead, increase with temperature and the more rapidly the higher the temperature. The main increase in the reaction velocity is undoubtedly due to an increasing quantum yield, and the latter has been determined now at room-temperature by comparing the rates of water and of carbon dioxide formation with that of ozone. It is evident that around 500° quite long chains are formed on illumination in both gaseous mixtures, and while the above divergence is therefore eliminated to a considerable extent the possibility of infinitely long chains cannot yet be answered definitely. The mechanism of photochemical reaction appears to consist of two parts: (1) The immediate processes following light absorption, and requiring for their completion either none or a very small additional thermal activation energy. (2) The secondary-chain mechanism, which may be identical with the normal thermal reaction. H. H. Ho.

2863. Test of the Radiation Hypothesis of Chemical Reaction. W. Ure and R. C. Tolman. *Am. Chem. Soc., J.* 51. *pp.* 974–983, *April,* 1929.

The viewpoint that thermal unimolecular reactions are to be considered as photochemical with the activating frequencies lying in the infra-red region is submitted to experimental test by subjecting a system to radiation from an outside source and determining whether or not the thermal reaction rate is thereby increased. It is found that the rate of racemisation of pinene is not acclerated by a large increase in the density of radiation over the range of wave-lengths out to 3μ. The nature of the present experiments does not warrant any conclusion as to the effectiveness of wave-lengths longer than 3μ. The work of Lewis and Mayer on pinene is criticised from the point of view of the justifiability of the conclusions which they drew as to the inactivity of the longer wave-lengths, and it is shown that they have not proved that radiation of wave-lengths out as far as 13μ is inactive in the thermal racemisation of pinene. H. H. Ho.

2864. Action of Optically-Excited Mercury Atoms on Hydrocarbon Molecules. W. Frankenburger and R. Zell. *Zeits. f. phys. Chem.* 2. *Abt. B. pp.* 395–398, *April*, 1929.

Experimenta were made on the effect of optically-excited mercury atoms on hydrocarbon molecules. A current of gas (air, nitrogen, carbon monoxide) was charged with the vapour of normal pentane at 0° C., and then exposed to the light of a mercury arc lamp, after the gas was saturated with mercury vapour at 50° C. The results showed that the excited mercury atoms brought about the removal of hydrogen atoms or the splitting off of the C–C linkage. The hydrocarbon radicals so liberated combined in the presence of an indifferent gas to form hydrocarbons with different lengths of carbon chain. In the presence of oxygen or carbon monoxide, hydrogen peroxide, formaldehyde, glyoxal, and other organic compounds containing oxygen were produced. F. J. B.

2865. Irradiation of Ergosterol. Action of Ultra-Violet Rays and Soft X-Rays. R. Delaplace and G. Rebière. *Comptes Rendus*, 188. *pp.* 1169–1172, *April* 29, 1929.

The ultra-violet rays from a quartz lamp were employed, and curves are given showing the results. The absorption spectrum alters in a somewhat curious manner during irradiation, and it has been suggested that a new absorption band formed is due to the change of ergosterol into vitamine D. This does not seem to be the case, since this band only differentiates clearly from the spectrum of ergosterol when the biological action strongly diminishes. Similar results have been obtained after irradiation with soft X-rays. H. N. A.

2866. Unimolecular Reactions. D. G. Bourgin. *Nat. Acad. Sci., Proc.* 15. *pp.* 357–362, *April*, 1929.

This paper is devoted in the main to an exposition of a view of unimolecular reactions based on new quantum-theory considerations. The fundamental ideas involved are very similar to those made use of recently in work on thermionic emission [see Abstract 3286 (1928)] and, more closely, the problem of radioactive disintegration [see Abstracts 62, 532, 583, 2212 (1929)]. In fact, the seeming necessity for a complex structure in the case of atomic and unimolecular disruption makes a formal analogy at least natural. Attention is fixed on a particular mode of decomposition described by the severing of a certain band for which a potential energy function is derived, the assumption being made of an intermediate region in which the energy exceeds the dissociation energy. The proposed explanation meets two tests satisfactorily—in the first place, in contrast with, for instance, radiation theories, it indicates that only the more complicated molecules, where extraordinary couplings may be expected, can exhibit the phenomenon of unimolecular reaction, and it accounts also in a natural way for constancy of the reaction rate under widely varying conditions; *e.g.*, even solution in liquids. H. H. Ho.

2867. Action of Helium on Platinum. H. Damianovich and J. J. Trillat. *Comptes Rendus*, 188. *pp.* 991–992, *April* 8, 1929.

By means of X-rays the authors examine the products obtained under various conditions of discharge, temperature, and air filling as well as helium, from the action of helium on platinum [see Abstract 2627 (1929)].

The X-ray diagrams show that all the products are microcrystalline, giving the Debye-Sherrer rings, but apparently a certain portion also exists as an amorphous powder. Except for a difference in the diameter of the rings obtained according to the process of formation, the diagrams are identical, indicating that the crystal form is the same throughout. In one case, where the material was formed under the action of a moderate discharge, the formation of a new microcrystalline substance is definitely shown by the X-ray diagrams. R. C. F.

2868. Short-Wave Radiations and Some Chemical Reactions. M. Conti. *N. Cimento,* 6. *pp.* 99–105, *March,* 1929.

The impact of short waves, from ultra-violet to X-rays, affects the e.m.f. of voltaic cells of various kinds. Experimental details; the effect depends upon the temperature and, independently, upon the wave-length. A. D.

2869. Reaction between Black Manganic Oxide and Salammoniac. C. Drotschmann. *Zeits. f. Elektrochem.* 35. *pp.* 194–198, *April,* 1929.

Investigates the behaviour of artificial and natural varieties of black manganic oxide in Leclanché cells. Cells were prepared with different kinds of MnO_2 and tested, more manganese was dissolved in the electrolyte when the artificial "active" product was used, but no four-valency manganese or compounds resembling peroxides were found in the solution. Hydrogen was given off in considerable quantity from a cell with slow reaction, natural MnO_2, when it was left for 26 days in open circuit, but very little from one prepared with highly active, artificial MnO_2. The corrosion of the zinc was much greater in the latter cell than in the former; this seems to be due to the oxydising properties of the artificial MnO_2, which also accounts for the small amount of free hydrogen produced. Any source of oxygen, even that from the atmosphere, causes strong corrosion of the zinc in Leclanché cells, and makes them run down on open circuit. The free ammonia formed is less with the active than with the inactive MnO_2; this is due to the greater adsorption of the former, owing to its large surface. The Cl-ions which remain act upon the zinc, dissolving a considerable quantity of this; another result is that only a small amount of insoluble double chloride of zinc and ammonium is formed in cells made with artificial MnO_2. H. N. A.

2870. Differential Potentiometric Titration. Part III. Improved Apparatus and Application to Precision Measurements. D. A. MacInnes and M. Dole. *Am. Chem. Soc., J.* 51. *pp.* 1119–1127, *April,* 1929.

The former apparatus is improved by the introduction of a simple gas lift pump. The apparatus can give precise measurements as shown by titration of ferrous sulphate with potassium dichromate, titration of chloride solutions with silver nitrate and in the analysis of constant boiling hydrochloric acid. [See Abstract 497 (1928)]. J. K.

2871. Studies of Electrolytic Polarisation. Complex Cyanides. Part VII. Silver. Part VIII. Copper. S. Glasstone. *Chem. Soc., J. pp.* 690–713, *April,* 1929.

Silver cyanide was dissolved in sodium cyanide solution, and the kathode potentials and current efficiencies were measured at different current densities, and with different amount of excess sodium cyanide.

The influence of stirring, temperature and dilution of the electrolyte has been investigated. It appears possible that ions such as $(Ag_2CN)^{\cdot}$ and $(Ag_3CN)^{\cdot\cdot}$ may exist in solution and it is suggested that the presence of such ions in an argento-cyanide solution, even if only to the extent of 10^{-4} gm-ion per litre, would account for the deposition of silver. The equilibria would be $Ag(CN)_2' \rightleftharpoons Ag^{\cdot} + 2CN'$, and $2Ag^{\cdot} + CN' \rightleftharpoons (Ag_2CN)^{\cdot}$. At the kathode silver would be deposited as follows: $(Ag_2CN)^{\cdot} + \ominus \rightarrow Ag\downarrow + Ag^{\cdot} + CN'$; the deposition of silver is here a secondary process, which explains the physical nature of the deposit. The possible influence of sodium, potassium or carbonate ions on the form of the deposit is discussed. Similar observations have been made with a number of cuprocyanide solutions. The difference in behaviour of copper and silver in complex cyanide solutions is connected with the fact that a small increase in the ratio of cyanide to metal ions in the case of copper raises the electrode potential to a point at which the evolution of hydrogen is possible. H. N. A.

2872. Transference Number of Barium Chloride as a Function of the Concentration. G. Jones and M. Dole. *Am. Chem. Soc., J.* 51. *pp.* 1073–1091, *April*, 1929.

The method of Washburn for the determination of transference numbers of chlorides was improved in details, making the method more precise, especially in dilute solutions. The transference number of the barium ion in barium chloride solution was measured at 25° C. at concentrations ranging from 0·01 to 1·035 molal, and it was found to vary from 0·4378 to 0·3514 over this range. The limiting value of the transference number of the barium ion in an infinitely dilute solution of barium chloride was found to be 0·4476 at 25° C. Measurements were made of the e.m.f. of concentration cells with liquid junctions containing barium chloride over the same range of concentration, 0·01 to 1·0 molal, and a formula was developed for calculating the transference numbers by the use of Lucasse's data on concentration cells without liquid junctions. Formulæ were also developed for calculating the transference numbers and the mean activity coefficients. F. J. B.

2873. Activity Coefficient of Diacetone Alcohol in Aqueous Salt Solutions. G. Åkerlöf. *Am. Chem. Soc., J.* 51. *pp.* 984–997, *April*, 1929.

Measurements have been made at 24 ± 1°, using an interferometric method to determine the partition coefficient of diacetone alcohol between the salt solutions and an insoluble organic liquid. The results obtained agree closely in order of magnitude and distribution with the results of the calculation of the activity coefficient of ethyl acetate in the same salt solutions from solubility measurements of Glasstone and Pound. The relative activity coefficients for some permanent gases in these salt solutions are apparently also of the same order of magnitude, and give most probably the same distribution as obtained for diacetone alcohol and ethyl acetate. A short discussion is included of the relation of the data to the theory of Brönsted of velocity of reactions catalysed by strong electrolytes. H. H. Ho.